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Marked Advances Shown in Designs of 1935 Automobiles

By Austin M. Wolf

Chrysler Airflow

A NEW milestone of progress has been set up by the automobile industry. A number of important developments have been incorporated in the new cars and the voluminous amount of detail refinements to be found in practically every model indicates the unceasing engineering activities of the various manufacturers and their continual desire of ever creating a still better product. The performance and beauty of appearance of all cars and especially those in the low-price group have reached a new zenith.

Those who had hoped to see a rear-engine passenger car in production will be disappointed but the bus industry has stolen the lead in this respect. The streamlining effect given commercial vehicles has given them a new standard of beauty which only a few years ago would never have been associated with a revenue-producing vehicle.

Significant developments of the year include high compression with cast-iron heads, the cadmium-silver-copper alloy bearing, "centrifugally-weighted" clutch release levers, "electric-finger" gear-shift control, rear-engine bus drives, the increasing use of hydraulic brakes, shifting engine weight forward, new independent springing systems, narrow shell radiators and the steel roof.

New models that have appeared are the Packard "120," the small Lincoln V-12, the Pontiac-6 and the small Graham-6. Buick has been content with extensive interior changes. Cadillac does likewise and has new style bumpers and a modification of the grille construction under the radiator. Mechanical changes are largely a matter of details and general improvement of manufacturing methods.

[This paper was presented at a special meeting of the Metropolitan Section on Jan. 3, 1935.]

Packard "120"

Dodge

Engines

A formidable accomplishment is high compression ratios with cast-iron heads. Topping the list is the Studebaker Dictator with an optional 6.9-1 ratio, followed by Plymouth with 6.7. The Pontiac-6 and 8 with 6.2 as standard have an optional 7.1 head. The highest ratios in aluminum heads are the Chrysler Imperial with 7.45-1 as an optional ratio and 7-1 in the DeSoto Airflow (6.5-1 standard on both). Hudson and Terraplane have special heads of 7-1 ratio of the composite aluminum-iron type.

The Oldsmobile flat combustion-chamber roof with vertical end wall has been dropped in favor of a slightly domed roof curving down toward the piston which is nearly flush with the top of the block instead of 1/16 in. below, decreasing the amount of combustible mixture in the clearance space and improving detonation characteristics. Hudson and Terraplane have provided a larger space around the inlet valve, increasing volumetric efficiency. Packard has adopted aluminum in all cylinder heads and increased the compression ratio. Auburn has likewise standardized on aluminum.

Bohn has developed formulas for the major combustion chamber dimensions, based on extensive laboratory tests, using gasoline of 70 octane value and an average compression ratio of 6.3-1. Federal Mogul has developed a copper alloy head with compression ratios up to 8-1, resulting in greater power output, better fuel economy, elimination of hot spots, less carbon accumulation and more complete combustion. The Packard steel-asbestos cylinder head gasket is cadmium plated. Prior to screwing the cast-iron barrel of the Doman & Marks engine into the aluminum alloy head, the threads are painted with a high grade aluminum paint which prevents leaky threads.

Plymouth and Dodge utilize full length water jackets. The White 12-cylinder truck engine has wet sleeves, there being three rubber rings in the base of the block with a drain groove between the two lower rings. The top is sealed by the usual head gasket and there is a special one at the base of the sleeve top flange in which a narrow circular contact is made with the copper of the gasket supplemented by a triangular gasket formation hugging the conical base of the flange. Campbell, Wyant & Cannon Foundry, in addition to having developed cast-iron cam and crankshafts, are now manufacturing centrifugally cast dry and wet cylinder sleeves. Pontiac uses chrome nickel iron for its blocks.

Valve Gear

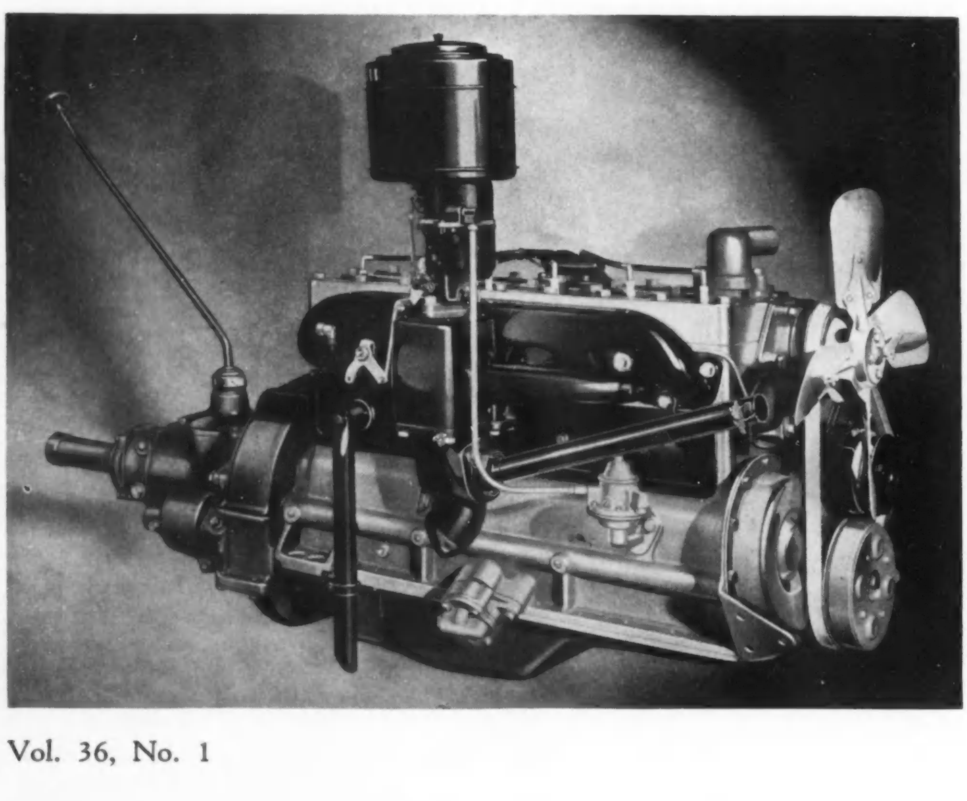
The Packard high chrome alloy exhaust valves are produced by the Detroit Motor Valve Co., utilizing an extruding process which is claimed to decrease head warpage. The "120" valves are set at an angle. Buick continues with the copper plating of the exhaust valve stems. The Pontiac valve stem guides are tapered to prevent valve sticking. The valve cover plates are double, separated by sound insulating material. Increased power development in the Chevrolet is principally due to a change in the valve seat angle from 45 to 30 deg. Each inlet valve port has been reshaped to form a venturi in which the seat angle forms a part.

Auburn Supercharged-8 Engine

To obviate surge, Oldsmobile valve springs have three closely spaced coils at the upper or stationary end which close up successively under compression. The Thompson tongue-and-groove spring retainer lock has been extended to Lycoming, Reo, Cadillac, Nash, Hercules and Chevrolet, the latter having adopted the single tongue type. Ford has a new cast alloy iron camshaft.

While Hudson and Terraplane retain the same tappet design, a 3 in. radius is now used instead of 1½ in. to increase the valve dwell. The Oldsmobile adjusting screw heads are polished where they contact with the valve stems, insuring more permanent adjustment and quiet operation. The valve opening and closing points on the 6-cylinder Oldsmobile engine have been advanced 5 deg. as measured on the crankshaft, permitting easier flow.

The Buick "40" has a Linkbelt non-adjustable drive, ½ in. pitch, with a cast-iron camshaft sprocket. The other Buick models retain the gear drive with steel against Textilite. The Celeron spoke-type gear is used on Studebaker and several



Pontiac-6 Engine. Note tube to carry fan draft to manifold hot spot thermostat for more equalized temperature control

G. M. C. and International truck motors. Long life and quietness result from resiliency of the material and the lack of synchronization with critical speed harmonics and other vibrations.

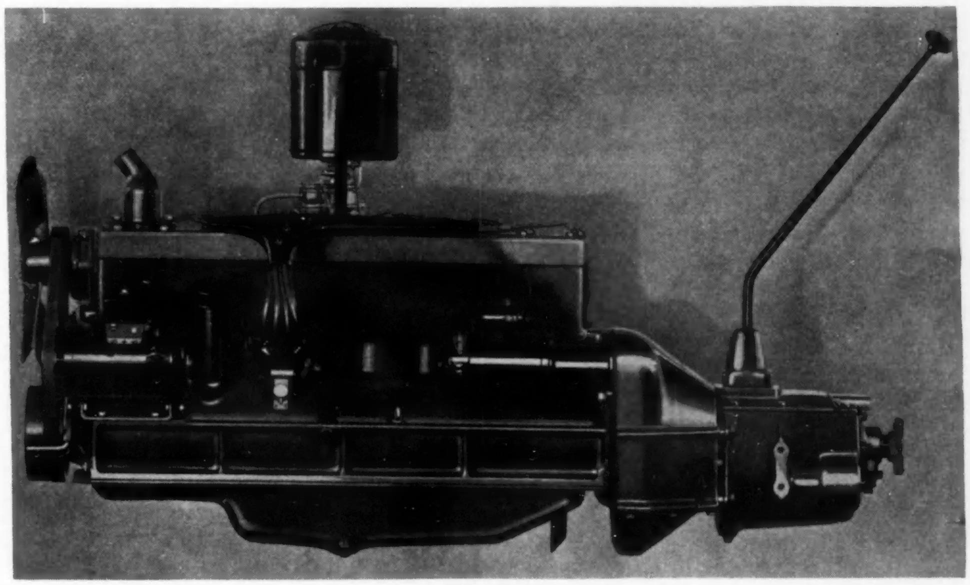
Piston and Connecting Rod

The Hudson and Terraplane aluminum alloy pistons are provided with a broad top land, below which are located two 3/32 in. compression rings and a 3/16 in. oil ring. The second oil ring is placed below the piston pin, the rings being still pinned. Chrysler and DeSoto pistons are given an aluminum oxide coating 0.00025 in. thick, taking in also the ring grooves and the piston pin hole, by immersing 17 min. in a solution of sulphuric acid kept at 70 deg. temperature. The corner actually twists the ring in the groove, causing the lower corner to maintain constant pressure against the cylinder wall, forming an oil seal on both the up and down strokes.

The Buick "40" connecting rod which originally had a 45 deg. split is now divided horizontally in the conventional way, being sufficiently narrow across the bolt bosses to permit withdrawal through the bore.

The Oldsmobile rods have been materially strengthened at the junction of the shank with the upper bolt bosses. The Chrysler connecting rod assemblies are accurately balanced about the same center of gravity and are held within plus or minus 2 grams. Pontiac rods are rifle drilled and the center of gravity is held at exactly the same point. The weight tolerance is within 1/16 oz.

Packard "120" Powerplant



Packard "120" engine has aluminum pistons. Chevrolet and Pontiac now tin plate the piston to a thickness of 0.0005-0.001 in. and the White-12 truck engine is similarly treated. Pontiac pistons are held to a uniform weight to within 1/16 oz. Chevrolet uses two ⅛ in. compression rings and one 3/16 in. oil ring. Plymouth, Dodge, DeSoto and Chrysler have two ⅛ in. compression rings and two 5/32 in. oil rings. Pontiac provides three ⅛ in. compression rings above and one 3/16 in. oil ring below the piston pin.

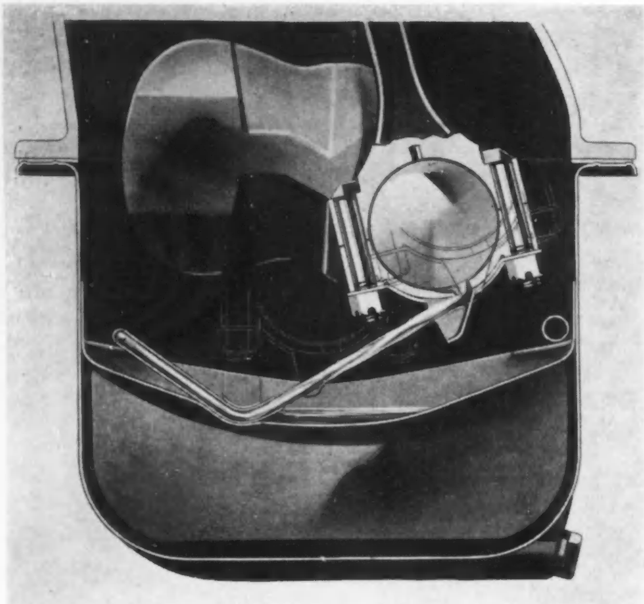
The Perfect Circle "70" compression and "85" oil control rings are used as standard equipment on Austin, DeSoto, Hupmobile, Oldsmobile-6, Studebaker, Cadillac, LaSalle, Pierce-Arrow, Dodge, Chrysler, Plymouth, Graham, Nash and Waukesha. American Hammered Piston Ring has developed a "power" ring having a center groove stopping short of the joint with a few ducts of predetermined size opening downward from the groove to the lower face of the ring. Traveling downward, oil is admitted into the groove under pressure which varies with the speed of the engine, providing a more effective seal at high speed. Oil is distributed through the ducts to the cylinder wall on the upstrokes.

The Super "C" compression ring of the McQuay-Norris aims to prevent rocking due to groove clearance. An angular inner structure creates a powerful torsonial force which in combination with an interrupted groove on the lower outside

Ford is now using copper-lead connecting rod bearings on the passenger-car engine as well as the truck. A.C. is furnishing its copper-lead lined steel-backed bearings to Packard. Packard continues with cap bolts integral with the connecting rod and a finned cap. A new development by Federal Mogul is the steel backed cadmium-silver copper alloy bearing, used by Pontiac in the connecting rods, Graham, Autocar and Cummins Diesel. It possesses higher impact values, a higher factor of safety at elevated temperatures and does not require as hard a crankshaft as copper-lead. It can be spun into the lower end of the connecting rod, being easily bonded and soldered to the usual bearing back materials.

Crankshaft and Lubrication

The Chevrolet crankshaft weighs 69 lb., being 5½ lb. more than last year. Counterweighting has been increased 80 per cent and the harmonic balancer has an additional spring in each bank and larger driving pins. Rotating forces are 90 per cent overcome. The crankshaft harmonic balancer, flywheel assembly, clutch cover and pressure plate are now selected so that in the assembly in any one engine any tolerated unbalances combine to cancel out one another. The total permissible unbalance for such an assembly is kept within one inch-ounce. The Oldsmobile-6 has a stiffer crankshaft with more counterweighting and larger pin bear-



Chevrolet Oil Jet Lubrication

ings. It is 85 per cent counterweighted as compared to 35 per cent in 1934. There is a counterweight at the center of the shaft between the third and fourth pins which requires counterbalancing at the "kidney" cheeks between 1 and 2 and 5 and 6 pins to maintain static balance. Both the 6 and 8 Oldsmobile engines have improved thrust design consisting of two separate hard bronze rings between the main bearing caps and the thrust surfaces on the shaft in place of the surface formed between the crankshaft and the flanges on the bearing shells. Pontiac and Packard "120" have fully counterweighted shafts. The latter has exceptionally large main bearings, the journals and pins overlapping nearly ½ in. Hercules has a few hundred cast crankshafts in bus and truck service.

A screened air scoop takes the place of the oil filler cap in the Ford V-8, receiving the radiator fan draft. The air is conveyed into the crankcase, up through the opening in the valve chamber and forward to a front outlet. The Pontiac crankcase ventilating system comprises a standpipe near the front of the case with a spring controlled door that relieves maximum inlet pressure which occurs above 45 m.p.h. Considerable interest centers on the Chevrolet lubricating system in which trough splash-lubrication occurs at low speed. A nozzle in each trough pointing upward directs the stream of oil in the path of the connecting rod dippers as they approach and pass bottom dead center. This results in a longer period for receiving the oil and at a higher pressure due to the velocity of the dipper against the oil stream. The oil grooves are twice as deep as formerly and a pocket is milled at the bottom where the grooves cross to provide a reservoir that is filled each time the dipper nears the oil jet. The oil pump capacity has been increased by enlarging the height of the rotor. The inlet and oil distributor pipes are increased in diameter.

Oldsmobile has obtained a 50 per cent increase in pump capacity by the use of special shaped gear teeth. The large Packard models have increased oil flow through the engine, bigger lines being used. Oil coolers are relocated in the block water jacket inlet. The 12 has a Cuno full-flow filter with automatic cleaning effected by changes in oil pressure through a piston operated ratchet. The "120" has rifle drilled rods. The Hudson and Terraplane pump is now at the camshaft level and driven therefrom. A feed line to the front lubricates the timing gears, the oil then draining to the front of the splash-pan. A second lead to the rear takes care of the back portion of the pan. The Oldsmobile-8 has drilled passageways in the crankcase in place of the previous copper tube manifold. The Pontiac lubricating system circulates oil at the rate of 175 gal. per hr. at 25 m.p.h. With full length water jackets as in the case of Plymouth and Dodge, the oil is kept at a lower temperature in hot weather and is warmed up more quickly in cold. A large cork seal with graphited surface is located at the Chevrolet crankcase front end cover. The contacting pulley hub surface is ground. The Socony-Vacuum Clearosol refining method utilizes two solvents,—propane for separating the paraffins and cresylic acid for extracting the required amount of unsaturated compounds from the refined product. The process produces oils of 100 V. I. and higher. Better oxidation and head resistances are obtained, as well as quicker flow at low temperatures.

Cooling

Besides the Pontiac, Oldsmobile-6 and Auburn, new recruits to the use of a longitudinal water distribution tube with openings adjacent to the exhaust valve ports are Plymouth, Dodge and Packard "120." In the Oldsmobile-8 which pumps 27 gal. per min. at 50 m.p.h., the water distribution tube is at the left side between the cylinders and the jacket wall in place of its previous incorporation in the water manifold plate. A simple external copper tube bypass connects the pump inlet with the cylinder head, replacing the spring-loaded bypass valve. In the Oldsmobile-6, drilled passages in the block and head replace the external bypass tube. In both the 6 and 8 an elbow tube of rubber is located between the pump inlet and the lower radiator connection.

A bellows-type thermostat is located in the water riser outlet of the Plymouth, Dodge, DeSoto and Chrysler with a direct return to the top of the pump housing. Studebaker provides a thermostat of the Dole type in the water line above the head outlet in which there is a concentric central outlet running back to the water pump. The Pontiac bypass also returns to the inlet side of the pump. The Hudson and Terraplane impellers are now provided with six blades in place of three and needle bearings on the pump shaft replace the plain bushings. The Chevrolet pump capacity has been increased through a ⅜ in. larger diameter impeller, forcing the water to flow more rapidly through the nozzles in the cylinder head. Special provision has been made for the installation of heaters by means of tapped holes in the water pump body and the side of the cylinder head near the front. Water drawn from this position is 10 deg. hotter than formerly when drawn from the rear of the head. The Ford pump is designed to use regular chassis lubricants.

The fan still stands out as one of the "noise spots" of the car. Automotive Fan and Bearing has gone still further in the variable spacing of the blades to change the noise characteristics and frequencies so that other noises will not be synchronized to give a greater apparent noise. The five-blade fan developed for the Cadillac V-12 and V-16 is of interest with a 65, 65, 92½, 45 and 92½ deg. spacing. Another unique five-blade fan is spaced 77½, 102½, 17½, 120 and 42½ deg.

With the forward location of the radiator in the White and A.C.F. buses with pancake engines, a door near the top

of the air duct permits warm air to be deflected on the inside of the windshield for defrosting. A duct could be easily incoporated in passenger cars for like purpose, conveying air from the engine compartment. In the Twin Coach rear engine bus an air scoop at the rear of the roof is carried down the back of the body with windows at the front and rear. The air passes through a diagonally placed radiator core in the duct and then into the engine compartment from which it is exhausted at each side by a shrouded engine driven fan. In the Mack rear-engine buses, the engine fan draws air in from the right side and blows it across the engine compartment and out through a radiator at the left side. In both these buses bottom pans are used to direct the air to the proper outlet. The White-12 truck drives its fan from the front end of the crankshaft. The Ford truck fan has been increased to 15½ in. diameter and is of the 6-blade type.

The narrow high radiator shell of considerable depth and greater forward slope is the present vogue in design. The Studebaker shell has horizontal fins along the side to increase the airflow of the core, the top fin lining up with hood louvre opening. The majority of the grilles are of vertical design, often with horizontal chromium plated bars for distinctive appearance. The grilles of the Ford, Dodge and Packard "120" curve backward at the bottom. The Chrysler Airstream has prominent vertical beads along the edges of the shell opening. Pontiac provides eleven vertical chromium-plated bars extending up the middle of the radiator, over the top of the shell and continuing along the hood to the cowl. Twelve vertical bars at each side complete the grille.

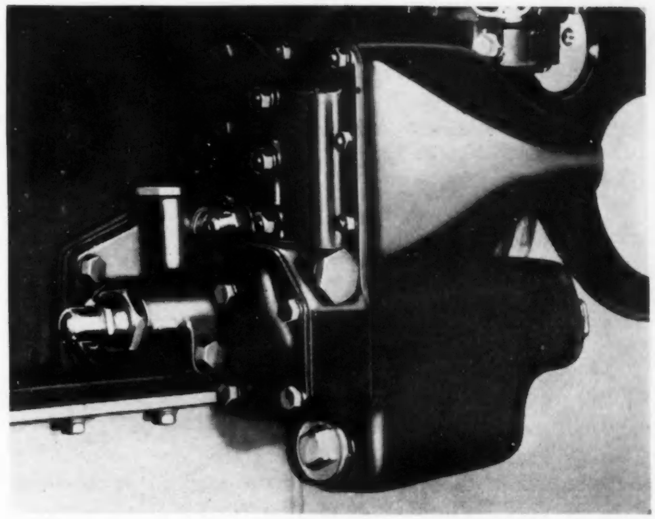
The Chevrolet, Plymouth, Dodge, Airstream DeSoto and Chrysler and Packard "120" have a filler under the hood. The LaFayette has a sealed water circulating system with a two-way valve built in the radiator. In the White-12 truck the overflow is sealed off when the cap is removed so that a definite quantity of air is trapped in the top tank. A valve is opened when the cap is screwed on, releasing the air, and the water above the seal drops to the top tank, leaving a definite expansion space therein.

Fuel and Exhaust Systems

The Marvel carburetor is used on all Buicks (except the "40") and on LaFayette which has a 1¼ in. single downdraft plain tube. Stromberg is used by Oldsmobile, Packard, Chrysler, Dodge, Auburn, Studebaker and Buick "40." Carter supplies Chevrolet, Hudson, Terraplane, Pontiac, DeSoto, Chrysler-6, Plymouth and Dodge, Reo and Studebaker trucks.

The Sisson automatic choke is used by Chrysler, DeSoto, Dodge and the Mack and Twin Coach rear engine buses. The fast idle feature of the Oldsmobile-6 is now used on the 8 as well—both cars incorporating the Delco choke in which a sylphon is used in place of the previous piston and a stronger thermostat spring minus the previous lock. The Oldsmobile 8 has in addition a dashpot to limit the opening speed of the choke valve. The automatic choke is optional on the 6. The Carter automatic choke ("climatic control") is used by Hudson, Terraplane and Pontiac-8.

Monroe Equipment Co. is supplying Terraplane and Willys "77" with a vertical type air cleaner-silencer in which the air passes through four thicknesses of No. 16 mesh screen and is deflected against a jute pad in the head sprayed with silicate of soda. The resonance chamber surrounding the duct from the cleaner consists of parallel, small diameter tubes



Packard-12 Self-Cleaning Oil Filter and Temperature Regulator

formed from paper treated with soundproof material. The Oldsmobile-8 cleaner is of the horizontal axis type. Burgess has a gimp-strand air cleaner and silencer in which the filament material is composed of a copper strip of small dimensions around which is gimped a spiral of copper ribbon which has a definitely springy quality. The result is a very loose mass of copper filaments in substantial spring-like form. Oil is held in the lower arcs of the wire in addition to that which sticks to the ribbon. The cellulose unit is continued and in both types acoustic entrances to the resonance chambers are designed for the particular frequencies of the engine for which the silencer is tuned.

In the Oldsmobile fuel and vacuum pump a baffle in the crankcase opening prevents excessive oil being splashed into the pump mechanism. A float valve is provided in the passageway to the intake manifold. Should the vacuum diaphragm rupture, the collected oil will cause the float to rise and shut off the connection to the manifold preventing the drawing off of all the oil from the engine. A passage is provided in the radiator shell to bypass cool air around the core and direct it on the fuel pump. Louvres in the right hand engine pan also help to accomplish this purpose.

Large low velocity manifolds are used by Hudson and Terraplane for better breathing capacity. The Oldsmobile-8 branches slope down to the block ports from the central riser. There is an open pocket below each riser to trap liquid fuel. A venturi unit is located in each and vaporizes the collected fuel by means of a stream of air drawn in through a ball check from outside the manifold when cranking. The venturi also acts as a drain to prevent flooding. Under running conditions the ball is sucked up to a seat shutting off the air supply. Plymouth, Dodge, DeSoto and Chrysler are equipped with the Bendix hot-spot thermostatic heat control. To insure quick warming up, Pontiac conveys the mixture through a thin steel tube extending through the exhaust jacket of the manifold. Auburn equips its models with a governor permitting not more than 35 m.p.h. during the breaking-in period or when driven from the factory where the governor is sealed and not removed by the dealer until the car has gone 1000 miles.

The Auburn-8 is offered with a certified speed of 100 m.p.h. or better, each car being checked and broken in at the factory. The Schwitzer-Cummins friction drive is used,

turning the rotor at six times engine speed. This 280 cu. in. engine, 3 1/16 x 4¾, has a 6.5-1 compression ratio and develops 148 hp. at 3900 r.p.m. and a maximum b.m.e.p. of 125¾ lb. per sq. in. at 2700. This same engine without supercharger and a 6.25-1 ratio develops 113 hp. at 3500 r.p.m., and a b.m.e.p. of 96 at 2700. There are two outlets from the supercharger casing, supplying the two section water jacket manifold. Duesenberg has a supercharged speedster guaranteed to do 165 m.p.h.

Studebaker continues with a filler opening projecting through the left rear fender. In the Oldsmobile it is located at the right fender which was selected since service records showed 28 per cent more left fenders being replaced. In the Chevrolet the filler is located on the left side of the rear apron, except in trunk-equipped models, when it extends from the lower central portion of the trunk above the fender. In the Ford truck, the filler extends diagonally upward at the right under the rear portion of the seat and is accessible when the door is open. The filler opening is combined with the license bracket in the Ford car and is located in the rear left fender.

The practical standardization of the antiknock value of the regular grade gasoline (between 68 and 70 octane number) by nearly all major oil companies has considerably simplified the designer's task of selecting suitable compression ratios. In the early summer of 1933 the marketing of lead-treated regular gasoline was started by a number of oil companies. Prior thereto, the regular antiknock value varied quite widely and in but few instances was as high as 66. It was then necessary to set compression ratios at a figure which would not be too high for the regular gasolines then available. Comprehensive field tests by the Ethyl Gasoline Corp. in the bus and truck fields have shown the economic value of the use of premium fuel. While propane and butane are exceedingly attractive as fuels, the question of distribution is still a vital one for fields removed from the sources of supply.

Muffler capacities have been increased in numerous instances. Burgess has developed an oval-shaped muffler giving economy of space and conforming to the trend of minimum overall height and full road clearance. It is used on the Chrysler Airflow. The Auburn supercharged models are fitted with four outside exhaust pipes covered with 3-in. polished stainless steel tubing that extend out through the hood and turn under the chassis to the muffler.

Electrical System

The ventilated generator first used by Hudson and Auburn last year is now found on Plymouth, Dodge, DeSoto, Chrysler, Pontiac, Chevrolet, and Oldsmobile. In the Oldsmobile "step-voltage" control, greater charging, with a battery partly discharged, is obtained by a resistance in series with the field windings and cut in or out by a set of contact points controlled by the line voltage. Any current drawn by lights or accessories reduces the voltage at the generator with the same result. The thermostatic control of output is controlled by a bar of special steel forming a shunt for the flux of the voltage control electromagnet. The bar's magnetic permeability at low temperatures increases more than ordinary steel, shunting more of the flux away from the magnetic armature which carries the contact points. The control box is dash-mounted avoiding engine vibration. Leece-Neville have developed a voltage regulator to be used on any standard 6-volt generator for passenger-car or truck use. It is apparent that voltage control is coming into its own in the passenger-car field. The increase in bus requirements has resulted in 1000-watt units. Twin Coach uses a Delco-Remy unit driven by a double V belt from the clutch end of the rear disposed powerplant. United American Bosch has a 1000-watt 12-volt unit with a cooling fan built into the rear end of the generator and provided with a cooling air inlet at the bottom, which can be placed in one of four different positions. The drive coupling has an overload friction clutch to absorb the inertia forces of the heavy armature in rapid acceleration and deceleration.

The Mallory model R distributor is provided with two diametrically opposite vacuum pistons with leather-tipped brakes replacing the former single piston unit. Plymouth, which initiated vacuum spark control, is using it as well as Dodge, DeSoto and Chrysler. The Chevrolet governor weights and cam are now machined parts instead of stampings. To prevent flutterings at high speeds a definite stop for the weights consists of a stamped steel cap which surrounds them.

On the large models Packard is employing a single coil to replace the former dual coils. The former dash-mounted Chevrolet coil is now carried on the right side of the engine above the distributor, reducing the high tension lead from 19 7/16 in. to 5½ in. and radio interference is minimized. The cap can be removed for servicing the electric car lock, yet is tamper-proof through the requirement of a special tool to unlock the internal spring tang locking the cap in place.

The Mitchell Specialty ignition switch used on Plymouth, Dodge, DeSoto, Chrysler, Hudson, Terraplane and Hupmobile is designed to prevent any appreciable resistance, being built up at the contacts during the life of the car. The customary molding of the contacts into the bakelite base, grinding off the face with the metallic parts and the bakelite flush, leaves scratches and wear ensues under the action of the switch rotor. In the Mitchell method the bakelite is molded without inserts and a piece of hard laminated bakelite is attached to the top surface, resting on shoulders of the special copper alloy contacts. The smooth glossy surface, instead of wearing under the action of the switch rotor, is burnished by it. Mitchell has a switch with a third position of the key to the left of the "off" position, permitting the radio circuit to be passed through the ignition switch to prevent unauthorized use.

A 10 mm. spark plug has been developed by A.C., but has not yet been incorporated in production engines. Increasing battery capacity is evident. The large Packards have a battery located under the rear floorboard, reminiscent of foreign practice. The 15-plate, 94 amp. hr. battery of the Pontiac-6 is claimed to crank the engine over at 47 r.p.m. at zero temperature with 10-W oil while the 17-plate, 107 amp. hr. battery of the 8 will turn the engine over at 52 r.p.m. under like conditions.

The Plymouth, Dodge, DeSoto, Chrysler and Oldsmobile-8 have starters controlled by a foot pedal in place of the previous coincidental switches or dash button. The pinion is initially engaged with ring gear before the current is applied, resulting in less burring of the ring-gear teeth. Nash and LaFayette continue with the coincidental clutch pedal starting. The Pontiac-6 starting motor is engaged by foot pedal while the 8 continues with the accelerator pedal-starter control.

The coincidental-ignition steering lock is now also used on the Buick "40," Auburn, LaFayette and Nash. The large Packard models are equipped with a Delco-Remy overload circuit breaker provided with a thermostatic flashing relay to warn in the case of short circuits.

Engine Mounting

The Firestone biscuit type of engine mounting is being used by Nash, Studebaker, Pierce-Arrow, Ford, Auburn, Hudson, Terraplane, Reo, Hupmobile, Graham, White, Indiana and Autocar.

Hudson and Terraplane provide two mounting points well above the crankshaft level on each side on an extension of the timing case rear plate. A wide rear mounting is located under the forward portion of the transmission case with a hold-down lug on each side. Buick and Oldsmobile use more rubber to reduce high frequency vibrations and transmission of noise. In the latter, the three point mounting consists of a point at the center of the front cross member near the lower edge of the timing chain cover and two diagonal mountings on each side of the bell housing with the elimination of the previous transmission support. Plymouth and Dodge retain the mounting point under the water pump and a diagonal mounting under the forward portion of the transmission case at each side, eliminating all other torque reaction elements. The Chevrolet mountings are entirely redesigned and the central supports are now bracketed to the clutch housing instead of the previous crankcase mounting. Pontiac has an angular mounting at each side at the front at approximately crankshaft level, a horizontal mounting at each side ahead of the bell housing and a mounting under the rear of the transmission consisting of two diagonal surfaces combined into one bracket.

Clutch

Whereas the automatic clutch actuation has been dropped from Plymouth, Dodge, DeSoto and Chrysler, it is interesting to note that Packard has adopted Bendix power operation on the 12 to obtain lighter pedal pressure. A reaction type control is used similar to the vacuum brake booster. A vacuum reserve tank serves both the clutch and brake cylinders. The Eaton clutch actuator reduces pedal pressure and eliminates the need of take-up adjustment. Engine torque is used to supplement pedal pressure by the reaction of a circular cam normally rotating with the clutch housing and which is retarded when the throwout mechanism is operated.

The shape of the cover on the Borg & Beck 9-in., 10-in. and 11-in. clutches has been modified to increase rigidity, reducing deflection of the cover at the eyebolt nut. The cover sides have been slanted in the shape of a flatter cone, to bring the metal supporting the eyebolt more directly in a straight line between the eyebolt nut and the flywheel. This also permits shrouding the springs with metal for about one-half their length, preventing bowing at high speeds. Ventilating holes have been added to the sides of the cover and 7/32-in. high radial ribs have been added to the pressure plate to act as a blower, producing forced air circulation. The springs which are now heat treated have been increased in number and the pressure plate lands on which the springs ride have been increased in height to provide a wider air gap. The improved ventilation has resulted in a considerable decrease in spring load loss from heat. To secure adequate ventilation, a screened opening is provided at the right rear side of the Plymouth, Dodge, DeSoto and Chrysler clutch housing. The air is expelled through vents at the forward end of the bell housing. A circulation of 600 cu. ft. per min. at high speed is claimed. With the pedal linkage used only 26 lb. foot pressure is required.

The Long "CF" series takes advantage of centrifugal force to give greater torque capacity at higher motor and slipping speeds which permits of lower spring pressure at normal operating speeds which amounts to approximately 30 per cent less than the conventional construction. Coupled with the elimination of friction through the use of needle bearings and a rolling contact in the clutch levers, clutch pressure is markedly reduced at normal operating speeds. The levers are provided with integrally forged weights at the outer ends. The 9-in. clutch has a normal spring load of 810 lb. to take care of an engine of 150 lb.-ft. torque which ordinarily requires 1140 lb. spring pressure. At 2000 r.p.m. the total effective load on the pressure plate becomes 1100 lb. and at 4000 r.p.m., the load is 1980 lb. Other Long features include a hardened steel adjusting screw at the inner end of the levers, a triangular shaped cover permitting maximum ventilation without sacrificing strength, the use of forgings at all vital points to reduce deflection losses and a new style vibration damper and cushioning springs that take the load both when accelerating and decelerating. The "CF" clutch is used in the Packard "120" and the Ford car and truck.

A ball-bearing throwout similar to the other Buick models is now used on the "40," replacing the previous graphite plate release bearing. The Oldsmobile graphite flowout is retained but the cast-iron contacting surface is backed by a hardened steel plate to prevent its being ridged by the clutch release levers.

The face of the Chevrolet driving plate consists of five tempered blades or segments bowed toward the flywheel and providing corresponding waves in the clutch facing. The leverage has been increased and there is a 10-lb. reduction in the initial load of the pull-back spring. The clutch release mechanism consists of two case hardened chain links between the pedal lever and the clutch releasing yoke with the aim of reducing friction.

Linderman Devices is offering a circular diaphragm for fluid pressure to obtain clutch release. The unit provides a self-contained construction eliminating end thrust and permits the engine to remain insulated from the frame during clutch disengagement. Current design nullifies the otherwise "float" of the powerplant during this operation.

Transmission

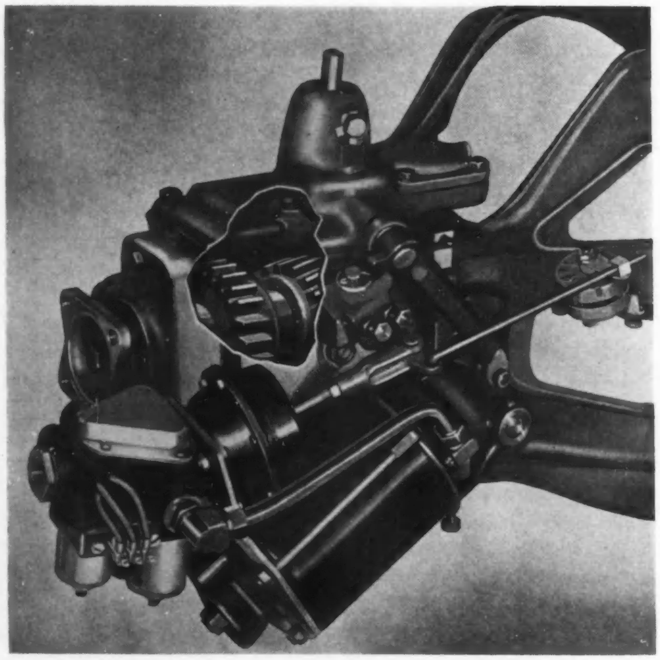
The outstanding transmission development is the Hudson and Terraplane "electric finger control" developed by Bendix and Hudson. A selector switch is mounted on the right side of the steering column comprising an H plate and a small lever extending therefrom. The switch is electrically connected with three solenoid valves controlling vacuum to either side of a shift piston and to one side of a spring-pressed selector diaphragm, all mounted on the right side of the transmission. An interlock switch on the clutch housing actuated by the selector diaphragm and a contact plate assembly, the moving member of which travels in unison with the forward or backward movement of either transmission shifter rod, are electrically connected with the selector switch and complete the equipment. A contact member is connected to the clutch pedal so that it is impossible to make a shift until the clutch has been disengaged. Current for the starter solenoid is also controlled by this contact requiring clutch disengagement before the starter control circuit is completed. Preselection is possible and the shift is made when the clutch pedal is depressed either with the foot or by the automatic clutch mechanism when it is employed. In the latter case, the actual shift occurs when the foot is removed from the

accelerator pedal. A stub lever projects from the cover assembly for emergency use.

A larger chamfer angle is used on the shifting gear teeth by Hudson and Terraplane to make an easier and more silent mesh possible. In the Plymouth, Dodge, DeSoto and Chrysler transmissions the all-helical gear construction is retained but synchromesh has been added. The Packard "120" does likewise, using hardened nickel steel gears. Free-wheeling is not used in the above Chrysler group except in the case of the overdrive which is standard on Chrysler and optional on the DeSoto Airflow and Chrysler Airflow-8. The Studebaker President's overdrive cuts in above 56 m.p.h. when the accelerator is released. Nash also uses the overdrive on its Ambassador models.

In the five speed transmission of the White-12 truck, a plunger pump is incorporated in the third-speed main shaft constant-mesh helical gear web and hub. The plunger is actuated by an eccentric on the face of the adjacent gear, assuring a constant supply of oil to the gear bushing. The rear engine buses disclose interesting layouts. Twin Coach and Mack have no direct drive, the power being transmitted from the mainshaft to the countershaft without return. This is possible by a bevel gear reduction in the drive. In the Twin Coach, the driveshaft from the engine extends to the opposite end of the transmission case where the clutch is mounted and the main shaft consists of a sleeve surrounding the driveshaft, driving the countershaft below through constant mesh gears except for reverse. A bevel gear on the engine end of the countershaft drives the universal joint shaft with a propeller shaft between it and the driving axle ahead. The universal shaft extends back and an American Chain disc brake is mounted thereon.

The Mack clutch is in the customary location. The bevel gear drive transmits the power to a transmission to the rear of the engine center line. The main shaft drives the countershaft below, the latter being in line with the propeller shaft.



Hudson and Terraplane "Electric Finger" Control Mechanism on Transmission

The bevel gear reduction is 20-31 and the speed ratios are 3.79-1, 1.83, 0.99 and 4.13 for reverse.

In the General Motors powerplant a transfer case at the back of the transmission houses a set of bevel gears which with the propeller shaft and rear axle pinion are set at an angle of 60 deg. with the longitudinal axis of the vehicle. Compressed air is used for gear shifting and clutch actuation.

Cooperating with Bendix Westinghouse, Spicer has adapted the air shift to a number of its transmission models. Spicer does not recommend its use unless synchronizers are used in all speeds but reverse. Trouble from gear chipping might occur, particularly in the hands of operators who are not skilled in double clutching when shifting both up and down.

In the rear engine bus remote control of the transmission is, of course, necessary. Mack uses a rod extending back from the front which can be axially rotated as well as shifted longitudinally, the selector mechanism being housed within the transmission case. Twin Coach provides cable control, there being two cables for each of the two control shafts which terminate in a double-ended lever.

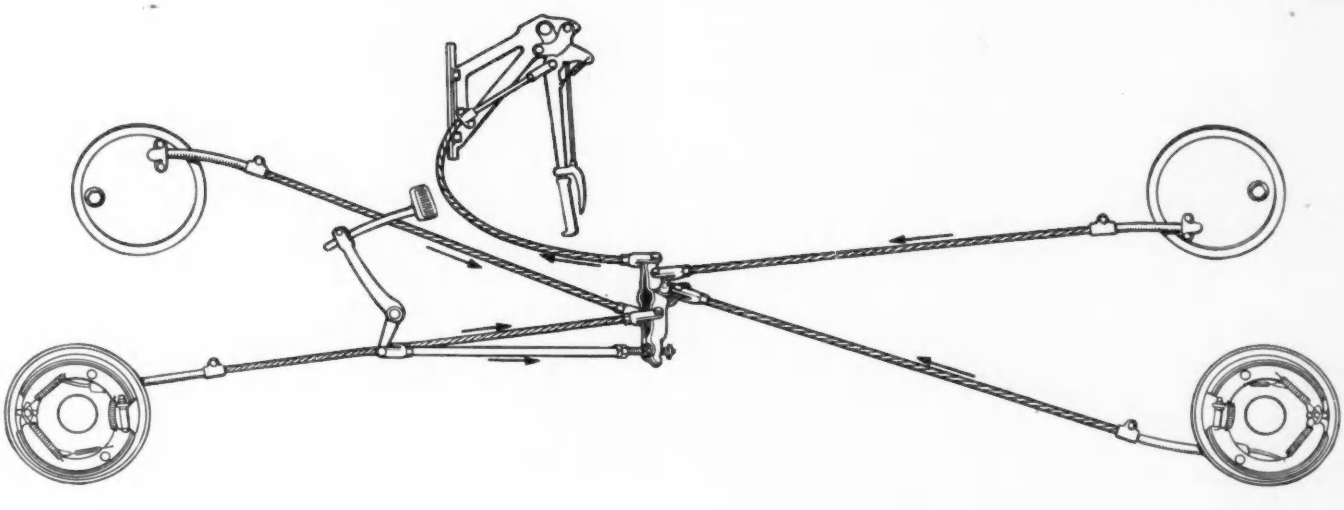
Fuller has developed a control for camel-back trucks. The gear shift lever actuates the control tube extending to a lever on a horizontal transverse shaft at the transmission. Side motion of the shaft for selecting is accomplished by a rod extending above the control tube with a yoke on each end and encompassing the tube. Side movement is therefore the same at the shift lever and the transverse selector shaft.

Universal Joints and Axles

Needle-bearing universal joints are generally used. Cleveland Steel Products has brought out an R-95 series in which a special lock spring is used to locate the bushings of the bearing assembly in the yokes by snapping over a groove. A slight deformation in the surface of the spring creates a pressure between the bushing and the yoke, preventing rotation of the bushing which is a very close sliding fit in the yoke legs. The problem of universal joint angles with an individual sprung rear construction is more acute due to the short length involved. The Leaf Spring Institute in their design found it possible to obtain under full-load an angle of between 1 and 2 deg. which becomes 7 to 8 deg. with no passengers in the rear seat. On full compression the angle varied between 15 and 18 deg. and on full rebound 22 to 24 deg.

The Packard "120," DeSoto Airflow and Chrysler Airstream-8 provide hypoid gearing in the rear axle. With increased engine output it has been possible to provide faster axle ratios without impairing acceleration or hill-climbing ability. Thus we find Oldsmobile, Plymouth, Dodge, DeSoto and Chrysler with different ratios. Oldsmobile provides 4.44-1 as compared with 4.55 in last year's 6 and 4.78 in the 8. The Chrysler Airstream-8 is geared 3.9-1 and the Airflow-8, 4.1-1. The latter when equipped with the overdrive is geared 4.3-1 and the effect of overall reduction in overdrive becomes 3.035-1. The dual ratio Auburn axle is now available at a slight additional cost.

The New Departure rear-wheel bearing, lubricated for life, has taken so well after its introduction on last year's Oldsmobile-6 that it is now standard equipment on the Oldsmobile-8 and several other cars. The spacing between the races of the pinion-shaft bearing of the Oldsmobile has been about doubled. An integral flange at the forward end of the outer race permits ready adjustment of the bearing position by shimming from the outside of the differential assembly. The



Hudson and Terraplane Rotary Equalizer. Note inverted hand brake with cable connection

differential bowl is offset to the left on the Mack and Twin Coach rear-engine buses in order to minimize the propeller shaft angularity which exists to a slight degree in plan view, the engines being on the right side. In the General Motors bus, the engine is at the left and the angular position of the propeller shaft and axle pinion permits the bowl to remain central.

Plymouth and Dodge have reverted to the tubular front axle which is also used by DeSoto and Chrysler Airstream models. Automatic knuckle pin lubrication through the swinging of the spindle is used by Auburn.

Brakes

Plymouth, Dodge and DeSoto provide a larger diameter piston in the wheel brake cylinder to actuate the rear shoe and thus compensate for the servo action imparted by the drum to the front shoe. The Oldsmobile wheel brake cylinders are rigidly fixed to the backing plate instead of the previous floating type. A new arrangement of return springs eliminates shoe clicking on reverse brake applications. Equal size pistons are used front and rear, the necessary braking distribution being obtained by the use of high coefficient of friction linings on the front shoes. Braking distribution is approximately 55 per cent front and 45 per cent rear. A single flexible hose extends to a transverse conduit on the rear axle in a protected position and replaces the two previous hoses. In the Studebaker layout the front piston of the wheel cylinder is larger than the rear (1¼ in. and 1 in.) to compensate for the added pressure on the rear energized shoe. The hand brake operates the rear wheel shoes mechanically as does Pontiac which has adapted the hydraulic method of actuation to the 1934 shoe layout. It is claimed that the car can be stopped in 4½ sec. from 80 m.p.h. The Packard "120" brakes are also of the hydraulic type. Ford uses a floating wedge to equalize the pressure applied to the two shoes. The linings are shortened but wider for more effectiveness.

Improved action and longer life of the linings on the Chevrolet are obtained by an arrangement insuring full contact of the reverse shoe during forward braking. A pin in the web of the T-shaped shoe engages with clearance holes in the Huck type articulating links, limiting the motion of the shoe in forward braking to prevent lifting at the heel. Hudson and Terraplane incorporate a rotary equalizer which is actuated by either the pedal rod or the hand lever cable. Brake cables are hooked to the equalizer at the same distance from center, the cables on one side of the pivot extending to the rear brakes and those on the other to the front. LaFayette uses a similar rotary control.

The brake selector has been dropped from the large Packard models and service adjustments are provided in the vacuum controls to regulate pedal pressure for various drivers. Hupmobile is using the Steeldraulic vacuum power cylinder. The control valve linkage is located in the pedal rod line and continues to a horizontal lever extending to the left from the center of the frame X-member. In the J and T models, the vacuum cylinder operates through a linkage to the lever, pulling to the left. In the W model, the cylinder is attached to the left rear X-member and pulls diagonally backward.

Centrifuse drums are used by Chrysler, Plymouth, DeSoto, Auburn-8, Packard, LaSalle, Reo-6A, and a number of trucks. Dodge uses a composite construction combining a ribbed cast-iron braking ring fused to a stamped steel backing plate. The Hudson and Terraplane drums are made of alloy steel, machined and polished. The sections have been increased 20 per cent to give greater rigidity while a more flexible type of brake shoe is used to assure concentricity. Oldsmobile and Pontiac use a high manganese steel in place of the previous No. 1025 to resist scoring. The Chevrolet Standard uses a special No. 1025 steel in combination with semi-molded linings. Additional ribs on the Ford drums give 40 per cent increased cooling area. There are innumerable instances of increased braking area.

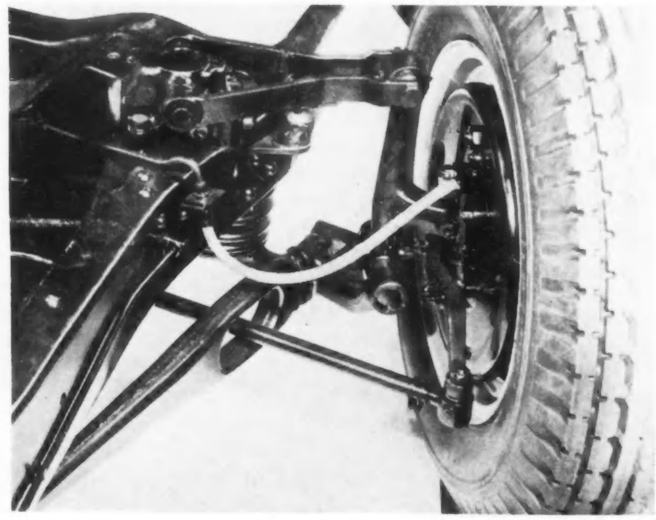
Linderman Devices has developed a diaphragm unit suitable for brake shoe actuation under fluid pressure consisting of a folded steel strip welded opposite the fold and bent upon itself as many times as necessary to produce the desired movement. A triangular strip between each bend maintains parallelism of the pack.

Wheels and Tires

The steel spoke artillery type wheel in its various forms dominates the entire field with a few exceptions in the lower-priced cars retaining wire-wheel equipment. First introduced several years ago on Pierce-Arrow, the Budd single-stamping design is used on Nash, Studebaker, Dodge and Hupmobile-D. In the majority of cases in order to accommodate axle constructions and body clearances, the brakes have been moved out in some cases as much as 1 in. resulting in a greater offset of the wheel center. The Motor Wheel designs include single and double disc constructions and are used on Plymouth, DeSoto, Chrysler, Buick, Hudson, Terraplane, Reo and LaSalle. The latter has balance weights which are projection-welded to the inside portion of the rim, equidistant from the light spot so that the total unbalance does not exceed 7 in.-oz. Only one weight is used if the unbalance is 1 oz. or less. The large Packard continues on wire-wheels using a disc cover while the small Packard has a single disc with a decided conical flair from the center. Pressed steel wheels with short rounded spokes are used in the three sedans of the Chevrolet Master series. Wire-wheels with large hub caps are used on the other models and the Standard. The Pontiac 6 has wire wheels with 48 spokes while the 8 has a 14-spoke stamped wheel.

All cars are equipped with 16-in. balloon tires with the exception of Chevrolet, the large Packards, Cadillacs, Lincolns, Pierces and the Auburn-6, although 16-6.25 tires are optional at extra cost with the latter. Tire equipment has settled down to the 16-in. basis, the sections being picked large enough so that pressures ranging from 25 to 35 lb. can be employed, which coincides with the recommendations of the original Firestone balloon in 1923. The U. S. Royal is now designed to give adequate resistance to skidding and satisfactory noise characteristics. Skidding resistance is obtained by a block tread in which there are two staggered rows on each side of the center rib. Firestone has also attacked the noise problem by the use of three center ribs, the central one of which has irregularly spaced triangular extensions at each side. The rib at each side and the tread edges are V-shaped to conform with the triangular center extensions. The irregular spacing voids the sound-forming tendencies of a symmetrical design.

It is interesting to note that in spite of the increased performance of cars, the tire companies have been able to build more mileage into the tires so that the 1935 cars will deliver non-skid mileage well above 20,000 in the hands of any owner who pays reasonable attention to inflation. While present design cars do not seem to have much tendency to shimmy, a better degree of balance is being held than in former years. A limit of 1/32 in. radial runout measured on the bead seat of the drop center rim is being kept. As a result of last year's experience it is not considered that independent suspension was unduly detrimental to tires. Uneven tread wear resulted on certain models where the front tire air-pressure was set too low. Firestone's investigation of the matter resulted in the recommendation that practically zero camber is exceedingly desirable. The Schrader Bulbtite and the Dill Super Seal Valve Stems are provided with a rubber base into which a flange of the stem is solidly cured and the base is then vulcanized to the tube wheel. Pontiac has added extensions to the rear spring shackles for a jack anchorage and pads have been placed on the side rails near the front. Modern overhanging bodies and fenders make such a measure desirable. The Chevrolet jack is clamped to either of the front bumper rear bars or to special seats provided on each of the attaching points of the rear bumper to the frame. The jack itself consists of a long heavily threaded solid steel shaft and a stamped steel base in which it can swivel slightly. The bevel gear nut unit moves up or down the shaft as the handle is rotated.



Packard "120" "Safe-T-Flex" Front Suspension

Suspension

Redistribution of weight plays an essential part of the entire suspension conception. Most cars have the engine shifted farther forward. The Packard large models have the engines 1⅛ in. ahead while the front axle has been brought back 2 in. The Chevrolet engine is 1½ in. ahead, Oldsmobile 5 in., Dodge 8 in., and the Ford car and truck 8 11/16 in. Front spring rates and frequencies have also been lowered. With practically a 50 per cent distribution of weight on each axle, Plymouth has front and rear frequencies of approximately 90 and 85 respectively.

The Chrysler Corp. has developed a carbon molybdenum steel known as "Mola" which can be safely stressed in excess of 125,000 lb. per sq. in. In the Plymouth, Dodge and DeSoto, the second leaf is closely wrapped around the main leaf at the spring eyes. The second leaf is interrupted each side of the spring seat to permit creep, with a spacer between. The leaf ends are tapered and the former spring discs omitted. A greater number of thin leaves are used to build up the spring. The Dodge front spring is 37½ in. long, 1¾ in. wide and has 9 leaves. The rear spring is 53⅝ in. long, 1¾ in. wide and has 10 leaves. The Ford front spring has been lengthened more than 4 in. and the ends of the leaves are tapered. The distance between front and rear springs is 123 in.

The Nash and LaFayette "synchronized springing" consists of Watson Silenite friction controlling inserts which require no lubrication and are fitted between the polished ends of the leaves, thereby maintaining constant friction. Rubber spring covers are used on all special models. The Oldsmobile rear spring front pivot bolts are of the threaded type as before but the tops of the threads have been cut out slightly to obtain greater lubricant capacity. The Ford car and truck front spring is located 4 in. ahead of the front axle, the mounting bracket being forged integrally with, and

forming an extension of, the radius rod yoke. Oilless bushings are used in the shackles. The construction permits moving the engine forward over the axle.

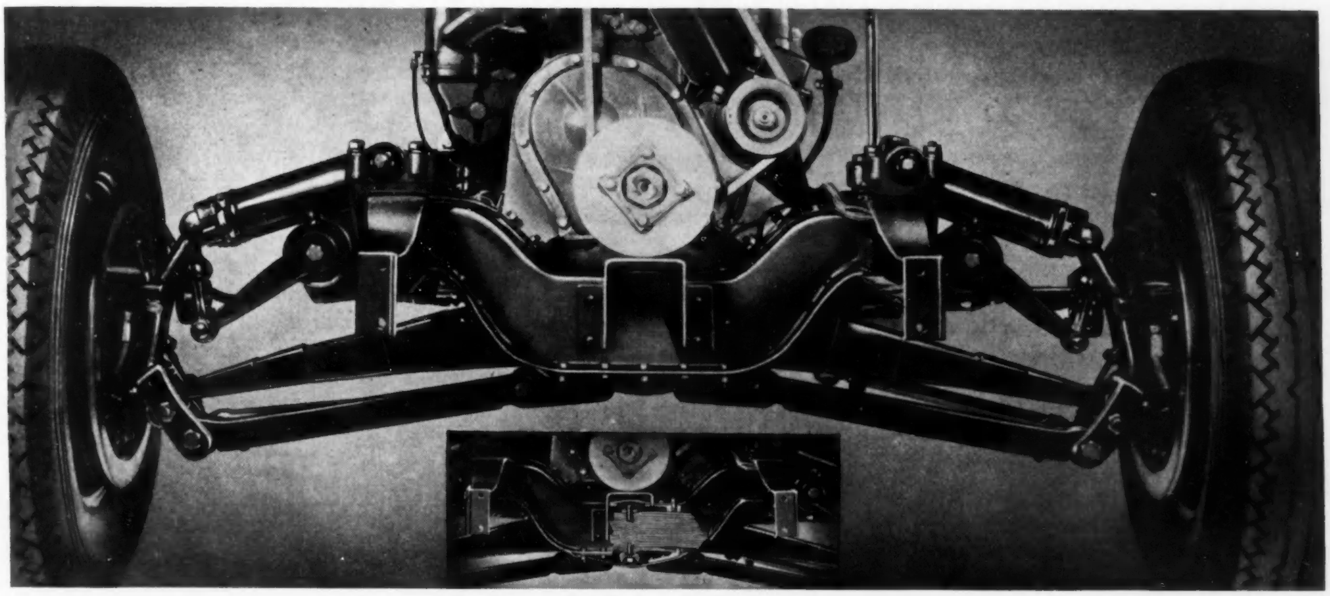
The sidesway eliminator inaugurated by Hupmobile is available on Hudson and Terraplane when the axleflex construction is used, as well as on Auburn and Packard "120." The Plymouth and Dodge "levelator" utilizes the same principle, the cross-spring rod being mounted on the axle with the side lever pointing forward. A link connection with rubber joints connects the lever to the frame. In passing over an obstruction, the soft spring on that side compresses and the "levelator" counteracts any swaying tendency. In the Chrysler and DeSoto Airflow models the spring rod is located forward but mounted on the frame.

In the parallel link or wishbone construction, Oldsmobile, Buick "40" and the DeSoto and Chrysler Airstream models have a shaft for each lower link replacing the original construction in which two pins were used. Greater rigidity and better alignment are obtained and permit the elimination of the former T-tray of the front cross-member.

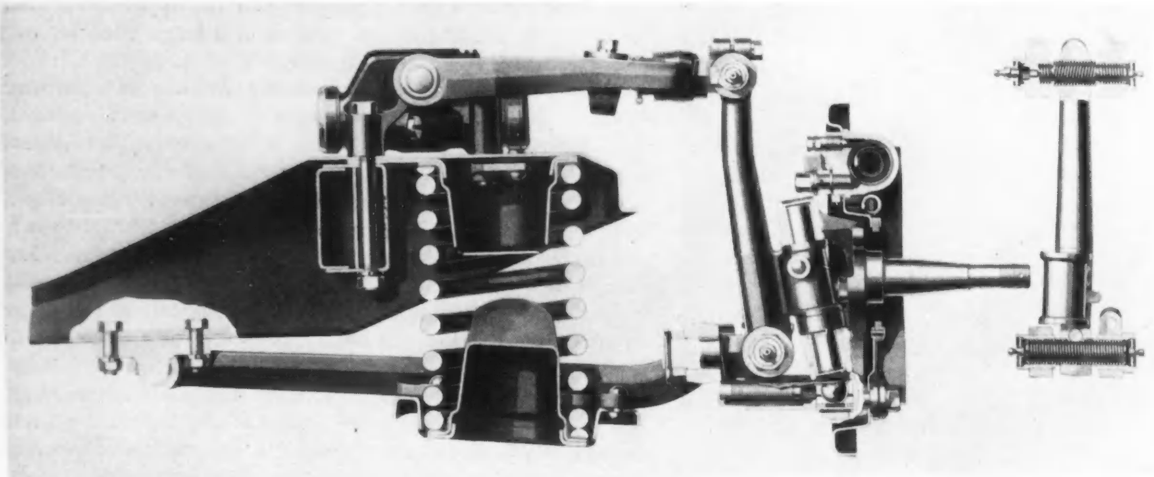
The Safe-T-Flex system on the Packard "120" involves a centrally pivoted single-arm link, pivoted close to the center of the front cross-member and extending outwardly to each wheel. It slopes back at a small angle and attaches to the bottom of the knuckle support. A coil spring transmits the frame load to this lower link as in other designs. A radius rod with a ball joint attachment under the frame rail runs forward and outward close to the link-knuckle attachment and takes all brake torque. The center link pivot is at an angle intersecting the ball joint, permitting proper oscillation of the wheel spindle. A short wishbone link is secured to the top of the knuckle support and is anchored to the usual double-acting shock absorber. The radius rod consists of two channel stampings, welded together and with a central slot through which the drag link passes to the customary center-steering-lever.

The Studebaker "planar" suspension consists of a front cross spring which is connected to the lower end of the knuckle support. A stamped link extends under the spring at each side maintaining the geometrical location of the lower end of the knuckle support. At the upper end a short link runs to the frame and consists of a large diameter tube welded to a fitting at each end. The outer one connects the knuckle support with a needle bearing at each side. Widely-spaced rubber bushed supports anchor the inner member to the frame and take the brake reaction. No tread change occurs in 4½ in. rise of the wheel. The spring consists of a large number of thin leaves of silico-manganese steel, 2½ in. wide and 48 in. long. The President and Commander employ 18 leaves while 14 are used on the Dictator where it is special equipment. The center of the spring is not rigidly secured to the frame cross-member but is positioned in a box which contacts with each side of the spring 4 in. from center. A U-bolt holds the hump-center spring leaves together and also a nest of thin spring steel plates at the underside which contact with the inside of the box and prevent endwise movement of the spring. Cam-shaped blocks at each side of the box transfer the car weight to the spring and permit its entire length to be utilized. Leaves are ground and polished on the tension side before heat-treatment. The second leaf has a half wrap around the main leaf at the threaded bushed eye and both are made without camber so that under normal static load they are under no stress. Metal boots cover the spring and rubber bushings are used on the lower link pins. Frame-mounted shock-absorber arms are actuated by a short connector to the upper end of each knuckle support.

The Leaf Spring Institute design utilizes two parallel springs below and a triangular wishbone above, connected to the shock-absorber and holding the knuckle support. A progressive pressed steel spring seat shortens the effective length of the springs under heavy deflections. The spring eyes are double-wrapped and an eccentric bushing and pin assembly provide camber adjustment and compensate for manufacturing variations in spring lengths. At the rear the springs are spaced farther apart so as to reduce the ground clearance under the differential which is frame mounted on rubber and has a propeller shaft extending to each wheel. A rear-mounted torsion bar is incorporated to overcome sidesway. In a 3000-lb. sedan, 40 lb. saving in weight is possible at the



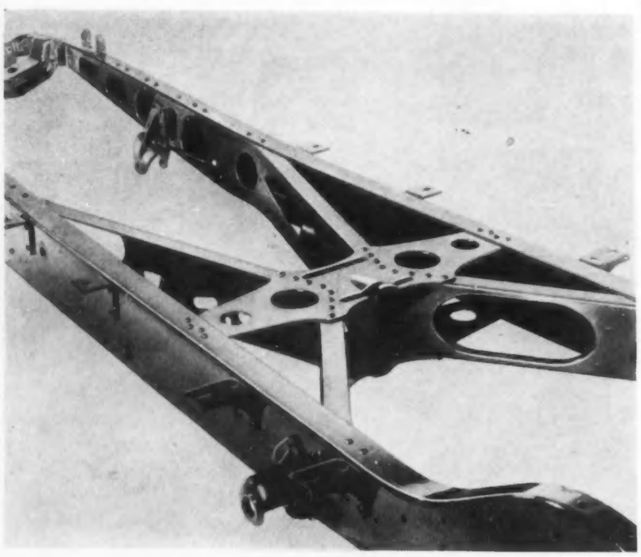
Studebaker "Planar" Front Suspension



DeSoto Airstream Individual Front Suspension with Side Rail Passing Through Front Cross Member and Supporting Through-Rod for Lower Wishbone

front and 100 lb. at the rear. It is possible to hold track variations in front to ⅜ in. with a 1 in. normal camber changing to a negative camber of ½ in. at full rebound. At the rear the track change becomes 9/16 in. at full rebound, 5/16 in. at full deflection and with a 1 deg. positive camber at full load, a negative camber of 2 2/3 deg. is obtained at full rebound.

Knee-action improvements in the Master Chevrolet consist of elimination of oil leaks and better ride control by changing the shock-absorber valve orifices and increasing valve spring pressure, slowing the rebound. The inner end of the wheel support arm shaft is of greater diameter and provided with a larger bearing containing 42 rollers. A new method of riveting the wheel spindle to the arm gives a 30 per cent increase in strength. Longer needle-bearings are used at each end of the knuckle pin where a convex disc facing the pin end and retained by a snap ring seals the bearing when lubricant is forced in under pressure. Weight has been shifted forward on the Pontiac and a lower rate coil spring is used in the knee-action on the 8 and DeLuxe 6. The Standard 6 has the conventional front spring.



Packard-12 Frame with Reinforced X-Member Center

Frames

The Buick "40" at its introduction presented a simplified frame construction in which the side rail passes through the front cross-member. The frame members are not drilled to take the front suspension assembly until after the frame has been assembled, at which time all bolt holes are jig-drilled simultaneously. The front cross-member is both riveted and welded to the side rails. In the Airstream Chrysler and DeSoto, the side rail passes through the front cross-member and is welded and bolted thereto.

A number of frames have additional channels welded in the side rails forming box sections. All holes are eliminated in the Oldsmobile X-member except those required during manufacture for riveting. The Chevrolet frames have channel inserts in the rear kick-up and the Standard has increased stiffness by the incorporation of an X-member. The Master has a new front cross-member and knuckle pin support consisting of a built-up box and channel section, increasing the front-end rigidity 24 per cent. The large Packard frames are sufficiently stiffened to make the elimination of the front tubular member possible. The upper torsion plate at the center of the X-member has been widened and is now anchored to the side rails. Ford has a new double drop X type frame with a heavier front cross-member. The frame is lower and the X-members are carried the full length of the rails to form box sections. The Packard "120" does likewise. A new welded box section joins the Ford X-members at the center, its top portion being curved to pass under the torque tube. Pontiac has a cross member which encompasses the center of the X-member. A heat-treated 2¾-in. cross tube supports the wheel units at each end and gives increased rigidity to the front end of the frame.

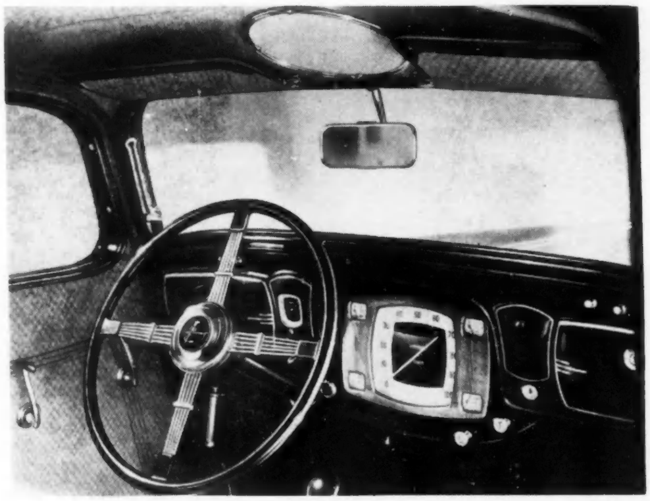
A tubular backbone design of the Leaf Spring Institute provides exceptional torsional stiffness. Channel side-rail sections at the front and rear are welded together to form the tubular center section. Channel inserts welded in the ends make full box sections.

Control

The Lavine steering gear provides a small diameter worm track at the base of the steering shaft which is engaged by two steel balls mounted in a retainer which is recessed on its back and slides on a pivoted tongue on the steering shaft lever. The shaft is mounted in full length needle bearings and a

needle bearing is located at the top of the steering column. To increase the efficiency of the Gemmer gear, the roller tooth is now mounted on angular contact ball-bearings, affording a full anti-friction mounting compared to the previous needle mounting with plain bearings at the two sides. The roller tooth mounting pin is electrically riveted instead of the previous peening. The column rubber bushing under the wheel which had a graphite core is now replaced by an angular contact ball-bearing assembly pressed into the jacket and held secure and free from making noise by the use of coiled spring compressed under the steering wheel.

Ford, Plymouth and Dodge have reverted to cross-steer which is also used by the Packard "120," Studebaker Dictator Standard, and the Airstream Chrysler and DeSoto. The Oldsmobile steering worms are of nickel molybdenum steel in place of low manganese alloy. The intermediate steering arm is now of T-shape with the base mounted at the pivot



Studebaker President Steering Wheel with Spring-Steel Rod Spokes. Note radio speaker in headlining

bearing, giving greater rigidity. Chevrolet has increased the shaft and bushing dimensions of the steering gear and a cork seal is used at the outer end of the steering shaft. A heavy steel stamping is bolted to the frame having a lug at each side to limit the travel of the steering arm. This arm and the steering third arm are shorter and stiffer. Hudson and Terraplane have reduced the steering arm length from 6 to 5¼ in. to increase the leverage. The Studebaker steering control is by drag-links extending from a Y-shaped arm near the left side rail, making a short left link and a long right one which alone is adjustable for toe-in. The President steering wheel has 4 chromium-plated spokes, each made up of five 9/64 in. spring steel rods.

Packard, Hudson and Terraplane have removed the hand-brake control to the left of the driver; it consists of an inverted pull-type lever resulting in a clear front compartment. The Pontiac hollow pedal shaft is filled with oil soaked felt which supplies lubricant for about six months.

Equipment

Headlamps have longer shells and are set low in the fender skirt. The shells are finished in lacquer in most instances with the occasional use of chromium plate. The Packard "120" has a distinctive faired rib on the top of the lamps. The Dodge and Oldsmobile headlamps are carried by the radiator shell. The Oldsmobile asymmetrical headlamp lighting system is retained. A thermostatic circuit breaker is used on the light switches. Plymouth, Dodge, DeSoto and Chrysler have replaced last year's asymmetrical layout with the parallel beam.

A small bulb (Tung-Sol T-51 and Mazda 51) has been introduced of low candlepower with a limited ampere draw which is popular as an indicator when the long range driving beam is in use. It was difficult on last year's cars where a foot switch was used to tell which beam was in use when another car was approaching. The lamp has a miniature bayonet base of 0.364-0.358 in. diameter and is also used for heater and radio indicators. A 1½ c.p. bulb (Tung-Sol T-55 and Mazda 55) also with the small bayonet base has been developed for a parking bulb in small headlamp reflectors of the short, small focal length type. The Mazda 1321 is a single-filament flanged prefocused headlamp bulb for use in spotlight and driving lamps. The filament is a straight horizontal coil with vertical legs.

Various instrument groupings have been developed in which compactness predominates. The Studebaker group is recessed in the instrument panel center, tilting forward at the top. All Pontiac dials are finished in brown with translucent green figures. Packard and Chrysler Airflow models have indirect lighting with the intensity of illumination controlled by a resistance. Lighting of the Dodge instruments is by means of two tube-enclosed lamps that light on being withdrawn and may be rotated to project their beams as desired.

Cadillac and Packard retain the ride control shock-absorber adjustment. Hudson direct-acting shock-absorbers are provided with replaceable valves, making it possible to obtain any individual type of ride desired. The Monroe direct-acting unit used on Terraplane, Reo and Auburn now has a pressure relief valve assembled in the piston and set to a predetermined pressure. The Plymouth and Dodge shock-absorber links extend upward over the center of the front axle, relieving it of any rocking tendency. The Plymouth, Dodge, DeSoto and Chrysler have double-acting shock absorbers at the front. The Dodge and DeSoto Airstream have single-acting rears while the double-acting type is used at the rear of the DeSoto and Chrysler Airflows.

With the advent of the steel roof, the radio antenna is now a U-tube mounted under the running board. It is usually suspended by rubber grommets which provide insulation as well as flexible mounting. A more sensitive radio set is required to compensate for the reduction in height of the antenna. The Studebaker speaker is mounted in the roof header between the visors and is flush with the interior trim. The Dodge and DeSoto Airstream tool compartment under the driver's seat is provided with spring clips to hold the tools in place and prevent rattle.

Sheet Metal

Due to the prevailing narrow radiator, a narrow panel extends between the fender crown and the radiator shell. In most instances the panel is concentrically curved with the fender. In the Studebaker, however, the panel has a concave form. To break up the wide effect, Dodge has a chromium-plated grille below each lamp providing an opening behind which is located the horn. The Packard "120" radiator shell is flared out at the bottom to form the convex panel which

meets the inturned fender extension with a chromium bead covering the joint and extending to the headlamp bracket.

The original streamline form of fender crown introduced by Oldsmobile is used in more or less modified form by Chevrolet, Pontiac, Plymouth, Dodge, DeSoto, Chrysler and Packard "120." In most of these cases the rear of the fender crown sheet continues back to form the running board extension. However, in the case of Pontiac and Chevrolet, the running board is continued ahead to the forward corner of the fender valance. With the chromium-edged beading of the running board, a more pleasing effect is obtained in terminating the crown on the running board. The Oldsmobile fenders are now separate from the board. A metal apron on the rear edge of the front fender prevents excessive splash.

Fenders fair rearwardly to a greater extent and are more highly crowned in most instances. The large Packard fenders have a V center line which is quite pronounced at the rear. The back half of the Pontiac rear fender is raked back and tapered down to merge with the bottom bulge of the rear body panel. The prominent motif in louvre design consists of several horizontal chromium-plated beads. In most instances almost vertical louvres extend between the outside beads. Hood doors are still retained by Lincoln, in which there are two rows located between three beads. The Oldsmobile hood top extends farther forward than the side panels in order to clear the headlamps. The rear edge of the Hudson and Terraplane hood conforms to the bottom front curve of the door.

Pontiac with Distinctive Grille Carried Over into Hood Top. Note tapered body sides above belt

Body

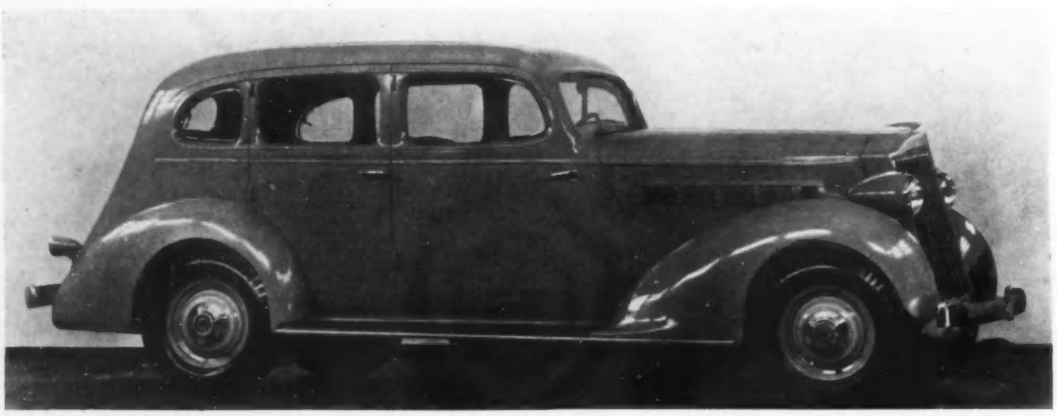
A greater slope of windshield, more slanting rear panels, more rounding roof contours and wider doors are incorporated in the new bodies. The Airflow Chrysler has a slightly narrower "hood" portion with correspondingly wider fenders. A V-type windshield is used by Oldsmobile in which two sections of glass are sealed at the center with a narrow strip. A non-drying cement between the body channels and the rubber gaskets and between the rubber and the glass seal the windshield against water leaks. The windshield wipers are mounted on the lower edge. Chevrolet and Pontiac have also adopted the V windshield which slopes at a 31½ deg. angle. The windshield wiper is also mounted below the glass, lying along the lower edge when not in use and sweeping an arc of 180 deg. when operating. A transparent visor is used on the Dodge.

The entire front end of the Chevrolet, Pontiac and Oldsmobile bodies forward of the doors is of steel construction. A truss member at each side joining the instrument panel, windshield pillars, cowl and body sills relieves the cowl deck and forward side panels of any structural stress.

The Chevrolet, Pontiac and Oldsmobile cowl ventilators now face forward. In the Studebaker and Terraplane the front windows can be moved rearward for ventilation after being fully raised upon further rotation of the regulator handle. A front window sliding back and then down from a closed position is used by Plymouth, Dodge and DeSoto Airstream. These same cars have a ventilating passageway under the front seat allowing circulation of air in the body.

The sloping front edge of the front door has been gracefully modified this year by a large radius swinging back at the bottom. The rear edge of the hood invariably follows this outline. By placing the hinges on a center body pillar, as in the case of Chevrolet, Pontiac, Oldsmobile and Packard, they become less conspicuous, suggesting smoother lines and can be spaced wider apart. The Chevrolet and Pontiac doors extend below the floor. The front doors are 43½ in. wide at the belt in the two-door models and 36 in. front and 28½ in. rear in the sedan. Hinges have brass bushings with an oil groove for lubrication. Adjustable braces are built into the doors. Rubber beading around the top of the doors and corner windows is largely used as a wind and water seal.

The metal roof is one of the distinct contributions of the year. Drumming is eliminated by padding between the top bows and the roof. In the case of Hudson and Terraplane



Packard "120" 5-Passenger Sedan. Note harmony of curves. Upper window curve starts downward, back of front door and lower curve upward at front door and rear window

the roof panel is welded to the body French panel in a trough extending around the entire roof. The trough weld is sealed with a viscous rubber cement and filled by an extruded rubber section resembling the conventional roof molding in appearance. The rubber has no value other than to provide a finish to the trough. In the Chevrolet, Pontiac and Oldsmobile bodies, the seamless steel roof panel extends from the top of the windshield opening to the rear to include the entire rear window opening and extends over the sides to include the drip molding. It is reinforced with U-shaped bows of heavy gage metal anchored at the sides to the hard wood framework. A 3/16 in. deadening felt is cemented to the under side of the metal to afford protection against sound, heat and cold. The same type of felt is cemented to the back, quarter and door panels of the Oldsmobile with waffle-shaped impressions stamped in, to form air spaces between the mats and the metals. All of the Chrysler group cars use Silento felt below the belt on all panels except the cowl and in the upper rear quarters. The sides and top of the cowl have insulations of ⅜-in. jute felt. The Chevrolet and Pontiac bodies are strengthened by the addition of steel braces extending diagonally from the sills to the belt under the rear window. These bodies are tapered in above the belt.

Seaman Paper Co. has developed a type "IN" Seapack with practically the same heat conductivity factor and sound absorbent coefficients as the previous type. The stamped waffle formations make it particularly adaptable for use on steel roofs, being lighter in weight than felt and with a higher resistance to heat transmission. This indented Seapack can also be used under the carpets, either being applied to the floor or attached to the carpeting.

Dual rear glass windows are increasing, being used on the Chrysler, DeSoto, Hupmobile "Aerodynamic," Hudson, Studebaker, LaSalle and Oldsmobile. Oriental walnut grain is very popular for instrument panels and window garnish moldings. The Chevrolet and Pontiac moldings are all-metal one-piece units. A continuous metal window channel of polished steel gives the effect of beading around the glass. Most cars carry the belt mold from the hood into the car. In the Chevrolet it is broadened on the doors and then tapered toward the rear. The top and side panels of the Ford hood each curve slightly inward at the hinge line. The depression is carried into the body and is continued below the belt and mildly across the rear panel. The general absence of moldings in most cases across the sloping rear panels increases their sleek effect.

The prevailing location for the spare tire is at the bottom of the luggage compartment with the tire in a horizontal position. The Dodge, DeSoto Airstream and Chrysler provide a gravity steel track to facilitate removal of the tire. The Studebaker rear tire carrier is arranged so that the top of the tire may be swung backward away from the trunk to give access thereto. In the LaFayette "Crown equipment" one spare demountable wheel is located in the right front fender well. De Luxe equipment on the Packard "120" includes wheels and tires in each front fender. The Auburn rear luggage compartment which is accessible from the inside of the body has 8½ cu. ft. capacity. When the car is equipped with a trunk, the space is increased to 13½ cu. ft.

The front seat in most cars has been widened to readily accommodate three passengers. Rear seats have likewise been widened, and there is greater foot room in the front and rear compartments. In moving the powerplant forward, advantage has been taken to move the rear seat ahead of the axle in order to locate the passengers closer to the center of the car. Pontiac provides a baggage shelf back of the rear seat which is 7 in. wide in sedans and 15 in. in the coupes. In the Chevrolet, Pontiac and Studebaker Commander, footrests have been built into a recess in the front seat. The Studebaker President rear compartment is fitted with hassocks instead of foot rests and has springs for soft cushioning. The Chevrolet has recessed arm rests. The front door arm rests of the Auburn are built over soft rubber pads. The Packard rear seats in the victoria and convertible sedan are adjustable so they can be moved back when the top is raised giving about 8 in. of additional compartment room.

Low-pile mohair velvet is popular in the low priced group. Broadcloth is the next choice. The Buick "40" convertible coupe is upholstered bedford whipcord or hand-buffed leather. Auburn places an overstuffed roll at the top of the front seat for comfort and attractiveness. Five steel cross-rods are sewn into the roof lining cloth to prevent sagging and to give a panel effect. The large Packards have the seats upholstered flat at the side with narrow pleats in the center. LaFayette provides shirred pockets at the back of the front seat. The Auburn door panels have a large pleated pocket with a zipper opening. The Studebaker President places sponge rubber under the carpets to give a soft effect. The Holtak waterproof tacking strip is rapidly replacing the customary craft paper which has a tendency to swell when wetted and to crack on drying out.

Streamlined door handles are popular. Auburn has Butler finish on the interior hardware and catalin knobs on all window regulating handles. The Chevrolet window and "venti-pane" regulator knobs are colored to match the window moldings. Bright nickel finish is used by LaFayette on the interior hardware. In the DeSoto Airflow the wedge is

Oldsmobile 2-Passenger Coupe with Distinctive Storage Space. Front door follows curvature of post

placed at the top of the door instead of the side, preventing soiling of the clothing and enabling the use of the door as a bracing member.

The underbody or floor of the Chevrolet and Pontiac is a single steel stamping, curved and ribbed, extending from the front end which is bent upward to form a toe-board to the extreme rear. Plymouth and Dodge, likewise, use a steel floor construction which is made an integral part of the body. The Oldsmobile running board which is separate from the fenders is entirely rubber covered and extends up toward the body at the inner side. The Chevrolet and Pontiac running boards are rubber covered between the fenders, allowing a conforming margin at each end. On the Auburn supercharged models and Duesenberg opera brougham, individual steps are provided in place of running boards.

Fuel Oil Engines

Besides the DHXB Hercules Diesel engine, 5 in. x 6 in. of 707 cu. in. displacement, a new DRXB $4\frac{3}{8}$ in. x $5\frac{1}{4}$ in., 474 cu. in. engine has been brought out identical in design except that the cylinders and crankcase are cast integral. With the precombustion chamber at the side of the cylinders, the velocity of the air, by gradually closing the opening to the chamber by the top edge of the piston, multiplies it about fifty times when fuel ignition takes place. The Waukesha Comet 6D series is being produced in three sizes—$4\frac{3}{8}$ in. x $5\frac{1}{8}$ in., $4\frac{3}{4}$ in. x $5\frac{1}{2}$ in., 5 in. x $5\frac{1}{2}$ in. with displacements of 462 cu. in., 585 cu. in. and 648 cu. in. respectively.

McCormick-Deering provides an auxiliary chamber in the head connecting with the combustion chamber through a controllable poppet valve. The total volume is sufficiently reduced to provide a reduced compression ratio so that starting on gasoline with spark ignition is possible. The engine is started by hand cranking and after it has picked up its cycle the governor automatically closes the poppet valve, shuts off the butterfly in the manifold from the carburetor, disengages the magneto and causes the fuel injection system to start functioning.

Ex-Cell-O has produced a fuel pump in which the filter and governor are combined in one unit for flange mounting at the back of the timing gear case. A swash plate actuates the pump plungers and the driving shaft is extended into the pump body to drive a central rotary valve. By-pass holes extend radially from each plunger to a fuel supply belt surrounding the rotary valve, being broken only by a triangular shaped land on the valve. Metering is obtained by controlling the axial position of the rotary valve.

Leece-Neville has developed cranking motors developing from 9 to 25 hp. and operating at 24 and 32 volts. Increased cranking speeds are necessary at low temperatures, not only to overcome the increased viscosity of the oil, but to increase the temperature of the air on compression in the cold head. The starting drive must be sufficiently heavy to withstand not only the cranking load but, on automatic drives, the violence of the shock of initial engagement as well as the deceleration torque of the starting motor. Leece-Neville found it necessary to devise switches permitting the pinion to enter into engagement with the flywheel gear on a lower voltage than cranking voltage. A switch with three stages of resistance has also been developed.

The Continental series R engine has been developed to start on gasoline and switch over when warmed up to No. 1 furnace oil. High intake manifold temperatures are used and the idling speed is stepped up to about 550 r.p.m. The crankcase is well ventilated to minimize dilution. Should the operator fail to switch over to gasoline when shutting down, the carburetor bowl is provided with a drain and filler.

Buses and Trucks

All-metal body construction is incorporated in modern design. In the case of Mack, rectangular posts of No. 12 gage copper-bearing steel are used in conjunction with duralumin panels. The CQ 31-passenger model weighs 15,100 lb. light. It is equipped with a 468 cu. in. engine developing 118 hp. at 2400 r.p.m. Twin Coach uses Nicral alloy T-posts and Z-bar floor sills. The 37-passenger model weighs 13,500 lb. and is equipped with a Hercules 529 cu. in. engine developing 126 hp. at 2400 r.p.m. To economize on space the cylinder axis is inclined rearwardly at the top. White and A.C.F. have new models of lesser seating capacity, equipped with smaller editions of their pancake engines.

The 12-cylinder White truck has its horizontal engine mounted above the dropped front end of the frame and over the front axle. It is mounted on a sub-frame so that it can be readily withdrawn with the transmission, radiator, emergency brake and instruments with all accessories.

Cabs are more roomy and comfortable, built more strongly and are provided with better ventilation. F.W.D. has brought out a $1\frac{1}{2}$-ton speed truck with the front axle $42\frac{1}{2}$ in. behind the bumper and a camel-back six-wheeler of 40,000 lb. gross capacity.

Autocar (*left*) and White (*right*) Trucks of Ultra-Modern Design

High-Speed Compression-Ignition Engines for Motor-Vehicles

By N. Mitchell

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OF the 455,000 trucks or passenger-carrying motor-vehicles in the United Kingdom at least 5500 are now fitted with compression-ignition engines, 57 per cent of these being fitted to passenger-carrying vehicles. The engines are of the direct-injection and of the separate-chamber types.

This paper does not discuss the merits of one system as compared with another, but merely the findings as regards costs and general service as derived from data supplied by the manufacturers and users.

By courtesy of the London Passenger Transport Board, data are presented on compression-ignition engines as compared with gasoline engines operating in the London area and the experiences regarding the adoption of the former are related. Another operating company has in service 50 vehicles equipped with Gardner direct-injection engines.

Several direct-injection systems are illustrated, and curves for comparative fuel-consumptions of the Leyland engine, using gasoline and using gas oil, are presented.

THE development of the high-speed compression-ignition engine, particularly in comparison with the modern gasoline engine, is at the moment attracting a good deal of attention in the United Kingdom. Users of public-service passenger-vehicles or trucks appear chiefly interested in comparative costs, whether it be for running or maintenance. With the conditions now prevailing in the United Kingdom there is no doubt that, from the point of view of running costs, the compression-ignition engine is easily cheaper than the gasoline engine. From the point of view of maintenance, however, the advantage is a debatable point. The author will endeavor, from information collected both from users and manufacturers, to throw some light on these questions of running and maintenance costs.

[This paper was presented at the Regional Transportation and Maintenance Meeting, Newark, N. J., Nov. 8, 1934.]

In the United Kingdom today, there are approximately 455,000 trucks or passenger-carrying motor-vehicles. Of this number, there are at least 5500 now fitted with compression-ignition engines, of which number 57 per cent are fitted to passenger-carrying vehicles. The manufacturers of these engines are not necessarily manufacturers of the complete vehicle. The engines may be divided into two classes; namely, the direct-injection (open combustion-chamber) and the separate-chamber type. The object of this paper is not to discuss the merits of one system as compared with another, but merely to set out the findings as regards costs and general service, derived from data kindly supplied by both manufacturers and users.

It has frequently been stated that the cost of maintaining road vehicles fitted with compression-ignition engines in proper running condition is higher than that incurred with gasoline units. There have indeed been instances where this higher maintenance has proved to be the case, and the opponents of the compression-ignition engine have felt justified in quoting these few instances in their support of the gasoline engine. It must be admitted that, particularly in the earlier days of the heavy-oil engines (compression-ignition engines), maintenance costs were unduly high, owing to the lack of experience of those entrusted with their manufacture, servicing and repairs.

It is perhaps true to state that, in comparison, the high-speed compression-ignition engine requires more expert knowledge to keep it in good running condition, but the probabilities are that what has happened in the past will be repeated; that is, that specialists in each particular unit employed will be found in the various assembly and erecting shops, dealing with the compression-ignition engine, so that in time it may be confidently anticipated that in respect to maintenance costs the compression-ignition engine will be on quite level terms with the gasoline engine.

The progress which has been made during the last three years is sufficiently encouraging to allow most operators of public-service passenger-vehicles and trucks to consider converting gasoline-engine units to compression ignition or

buying a complete chassis already fitted with the latter type of engine.

It may not be out of place to mention at this point that, although the design of combustion chambers, and the like, has played a great part in helping to bring both types of engine to what they are today, the producers of the fuels as well as the engine designers have contributed to the reduction of maintenance costs. This statement may appear exaggerated until it is realized that, if unsuitable fuels are employed in compression-ignition engines, the maintenance costs will be increased, due to the fact that there is a possibility of increased maximum pressure in the cylinders, resulting in increased wear. It is only by using fuels which, as a result of lengthy tests, have proved to be suitable, that maintenance costs can be reduced. It has been already realized that unsuitable fuels will cause injector valves to stick or distort and will increase the amount of carbon formed in the combustion chamber and behind piston rings. Both these factors entail engines being opened up more often and in turn must increase maintenance and running costs.

Improvement in the materials used plays an equally important part in the reduction of maintenance costs. The same may be said of lubricants. Users of vehicles fitted with compression-ignition engines have been inclined to consider fuel and lubricants as quite secondary matters, but it is now well established that different types of engines may require different types of lubricating oil. For instance, the direct-injection type, generally speaking, requires a more viscous lubricant than does the separate-chamber type. The reason for this is that dilution of the lubricating oil by fuel is a definite characteristic of engines of the former type, particularly where a central sprayer-position and multi-hole nozzle are used. In the case of the separate-chamber types, there is a general tendency toward thickening of the lubricating oil, and therefore a more fluid lubricant is desirable so that an oil viscosity may thus be maintained which will allow easy starting from cold.

It will be generally agreed that, at any rate for town service, the consumption of fuel in the compression-ignition engine in miles per gallon is approximately half that of the gasoline engine of equal power. It is difficult to translate this figure into cost in miles per gallon, as the price paid in various districts appears to vary not only absolutely but relatively. Even at equal fuel prices, it can easily be seen that the running costs of the two types of vehicles are very much in favor of that driven by a compression-ignition engine.

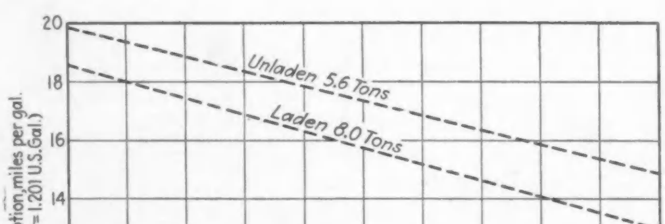

Fig. 1—Comparative Fuel-Consumptions of the Leyland 4⅜ x 5½-In. Engine Using Gasoline and Using Oil, the Axle Ratio Being 5.5:1

The tests were made at varying speeds, using the direct-injection system. The solid-line curves are for the gasoline engine; the dash-line curves, for the oil engine. One long ton = 2240 lb. = 1.12 short tons of 2000 lb.

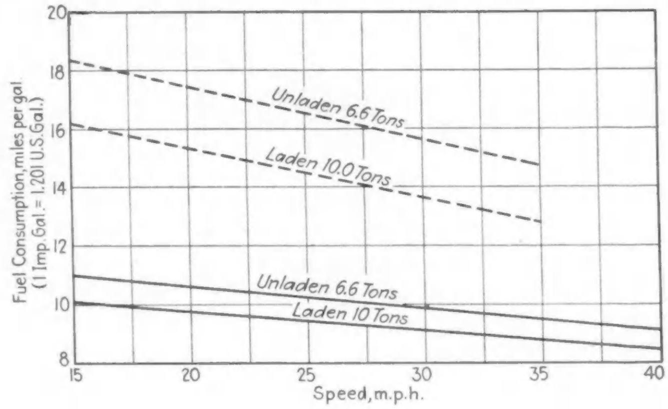

Fig. 2—Comparative Fuel-Consumptions of the Leyland 4⅜ x 5½-In. Engine Using Gasoline and Using Oil, the Axle Ratio Being 6.5:1

The tests were made at varying speeds, using the direct-injection system. The solid-line curves are for the gasoline engine; the dash-line curves, for the oil engine. One long ton = 2240 lb. = 1.12 short tons of 2000 lb.

Owing to the courtesy of the London Passenger Transport Board—better known by the old name of the London General Omnibus Co.—it has been possible to obtain some useful information on the subject of compression-ignition engines in comparison with gasoline engines, and the operation of these two types of vehicles in the London area. The L. P. T. B. service is perhaps unique in so far as the whole of the 5000 vehicles employed operate in or around London with a few exceptions, which may be termed "country services." The manufacturers of the great majority of the engines used in these vehicles are the Associated Equipment Co. of London, the engines used in the case of the compression ignition being described as the "separate-chamber type."

Service tests by the L. G. O. C. actually commenced in January, 1931, although previous experiments with Junker engines had been made on two lorries. Three vehicles were equipped with the A. E. C. Acro engine of 115-mm. (4.53 in.) bore by 142-mm. (5.59 in.) stroke. The construction of this engine was fairly orthodox, although bearings and reciprocating parts were naturally strengthened to withstand the higher maximum pressures. The overhead valves were operated by push rods and the well-known Acro antechamber was, of course, employed. Subsequently, a further nine engines of this type were put into service.

Meanwhile, an improved combustion chamber had been developed, this being spherical in form and communicating with the main cylinder by a short passage. The fuel was injected into the spherical chamber, a high degree of rotational swirl being obtained with this construction. This type is now known as the A. E. C.-Ricardo engine.

One of the Acro engines was converted in August, 1931, and the results were so encouraging that all the 12 engines were converted by December of that year, and a further 20 were put into service. By December, 1931, the total number of this later type was therefore 32. The fleet was further increased during 1932, a maximum of 94 being reached in October. The following month 11 Gardner 6-LW (direct-injection) engines were added, making a total of 105 oil-engine omnibuses at the end of 1932. The whole of these

were operated from one garage, this being from the latter date exclusively for oil-engine maintenance.

Further additions to the fleet were commenced in October, 1933, and by December, 1933, 179 vehicles were in service; of these, 168 had A. E. C.-Ricardo, and 11 had Gardner engines. At present 8 additional A. E. C.-Ricardo engines are being placed in service every week and by September, 1934, there were 407 vehicles. This certainly does not represent the maximum, as it is quite possible indeed that no new gasoline engines will be purchased by the London Passenger Transport Board. All the engines are fitted to A. E. C. "Renown" six-wheel chassis of the standard type operated in London, these being fitted with double-deck bodies seating 56 and 60 passengers. The unladen weight of the complete omnibus is 7¾ tons (1 long ton of 2240 lb. = 1.12 short tons of 2000 lb.) and the fully laden weight, approximately 11¾ tons.

Whereas some little trouble was experienced in the early days of the Acro combustion system with smoky exhaust, the performance of the present type of engine is now proving very satisfactory. The Bosch injection pumps are set to a standard rate of delivery and subsequently sealed so that there is no possibility of unauthorized tampering with the adjustment, and this insures that the quantity of fuel injected is kept within reasonable bounds and the smoke limit is not reached under service conditions. As a means of checking that the fuel pumps have been initially set to the correct standard, exhaust-gas samples are taken from each vehicle prior to its being released for service. For an engine in good condition there is a definite relation between pump delivery and carbon-dioxide content of the exhaust gases provided that the samples are obtained at full injection and at a standard engine speed, which, of course, must be below that at which the high-speed governor commences to operate. Control by means of exhaust-gas analysis is also adopted for the

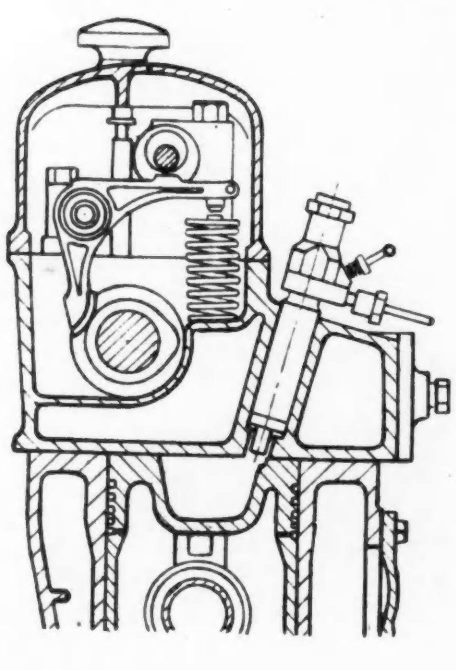

Fig. 3—Cross-Section of a Leyland Combustion Chamber

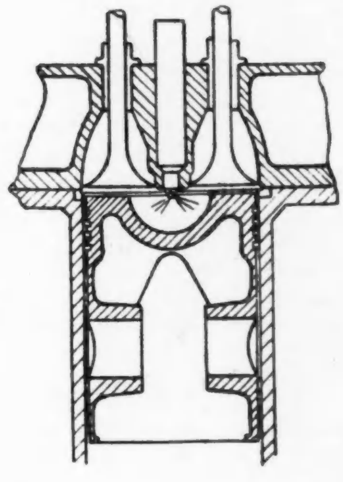

Fig. 4—An Example of the Direct-Injection System

vehicles when in service, the method being a normal extension of that previously established with considerable success for gasoline engines.

Another early trouble was failure of the big-end bearings. This has been entirely overcome by adopting a lead-bronze shell in the upper half of the rod, the material being similar to that used in many modern aircraft engines.

Cylinder-liner wear also proved to be high at first, but this has been overcome by the adoption of hardened piston rings in conjunction with hardened cast-iron cylinder-liners of 400 to 500 Brinell. The pistons are of aluminium alloy. The Bosch fuel-pump has proved quite satisfactory and it is found that the wear of the plungers is so small as to be negligible. The injector nozzles, which are of the pintle type on the A. E. C. engine, have also proved satisfactory and, provided they are cleaned and the pressures reset periodically, give no trouble in service. At present, the engines are still a little noisier than the gasoline engines when idling, but under load there is very little difference and it is considered very probable that the average non-technical passenger does not realize whether he is traveling behind an oil or a gasoline engine.

No complaints have been received from the public either in regard to noise or fumes. The drivers are also favorably disposed toward these engines, which they say give the impression of pulling more easily at low speeds. There is also a complete absence of detonation noise, heat and fumes in the cab.

With regard to maintenance, the engines are now subjected to exactly the same docking program as are the gasoline units; that is, the heads are removed and decarbonized and the valves ground-in once in 8500 miles. Major overhauls are carried out annually at the central overhaul-depot, after a service mileage of approximately 60,000 miles.

The following tabulation shows, in comparative form, the costs of the oil engine and the gasoline engine in London omnibus-service. These figures are based on experience over a fairly long period and should therefore be regarded as reliable. They may, perhaps, be slightly unfavorable toward the oil

engine, but the most recent experience shows that the maintenance costs are falling as the fleet is increased and becoming more standardized.

	Cost per Car Mile Expressed in Terms of Total Gasoline-Engine Cost (= 100) Gasoline	Oil
Maintenance, including overhead charges	40.0	45.6
Fuel	37.7	7.6
Licensed-vehicle duty, interest and depreciation charges	22.3	30.0
Total:	100.0	83.2

It will be noted that the figures relate to costs per car mile and that they are expressed in terms of total gasoline-engine costs, which are taken as 100.

It will be seen that there is a substantial reduction in fuel costs, although this is, to some extent, offset by increased maintenance costs. Oil-engine omnibuses are also subjected to a heavier excise duty, the annual difference amounting to $306.77 for a 56-seater.

In determining the difference between operating expenses of the gasoline-engine vehicle and the compression-ignition-engine vehicle, consideration must be given to the differences in taxation both on the vehicle and on the field.

Technical Details of the A.E.C.—"Ricardo Engine"

Bore and stroke, 115 mm. x 142 mm. (4.53 in. x 5.59 in.)
Swept volume, 540 cu. in., 8.85 litres
Compression ratio, 16:1
Maximum B.Hp. (smoke limit)[a], 128 at 2000 r.p.m.
Maximum B.M.E.P., 103 lb. per sq. in. at 1250 r.p.m.
Weight complete, less electrical equipment and flywheel, 1278 lb.

[a] The horsepower developed with the standard pump setting adopted for service is approximately 95 at 1650 r.p.m. = 85 lb. per sq. in. B.M.E.P.

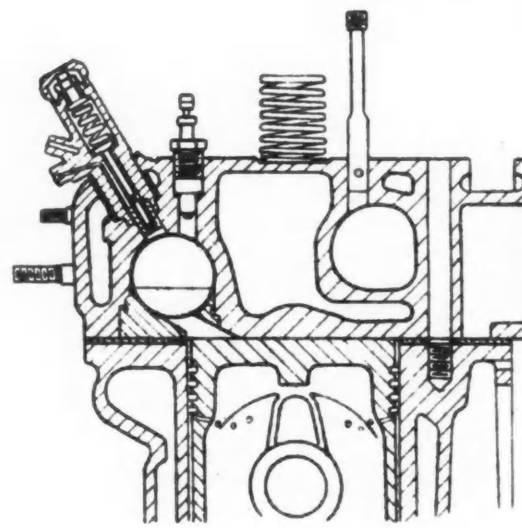

Fig. 5—Rotational-Air-Swirl or Separate Chamber in Which the Fuel Is Injected into a Small Chamber Connected by a Narrow Passage with the Cylinder Head

Certain bus companies employ engines of the direct-injection type manufactured by the well-known firm, Messrs. Gardner & Sons, Manchester. One operating company at the moment has in service 50 vehicles fitted with Gardner engines, and some of these engines have run over 130,000 miles to date. It is also of interest to record that big-end and main bearings of these engines require no more attention than do those of gasoline engines.

It will be remembered that, only two or three years ago, bearing trouble was considered one of the greatest difficulties with the compression-ignition engine. It is interesting here to see that great strides have been made in dealing with not only the design of the bearings but also the metals employed.

Unfortunately, no figures are available from the particular fleet of vehicles under review as to the life of cylinder liners in gasoline engines, but the Gardner engines in question had in some cases completed more than 90,000 miles before regrinding became necessary. It has been stated that users of these engines quite anticipate that the life of the engines without excessive maintenance costs will be in the order of 275,000 to 300,000 miles.

Operators of this type of engine appear to use the oil-consumption figure as indicating the need for regrinding. The average lubricating-oil consumption of an engine in good condition appears to be in the neighborhood of 1000 miles per Imperial gallon (1.201 U. S. gal.), but when the consumption

Table 1—Comparison between Compression-Ignition and Equivalent Gasoline Engines[a]

Compression-Ignition Engines (Direct Injection) Miles per Imperial Gallon (1.201 U. S. Gal.)	Fuel-Oil Cost per 50,000 Miles at 4½d. (9.4 cents) per Imperial Gallon (1.201 U. S. Gal.)	Equivalent Gasoline Engine Miles per Imperial Gallon (1.201 U. S. Gal.)	Gasoline at 1s. 2d. per Imperial Gallon (29.1 Cents per 1.201 U. S. Gal.)
8.8	£106 : 10 : 0 ($530 37)	4	£729 : 0 : 0 ($3,630.42)
11	85 : 5 : 0 (424.55)	5	583 : 0 : 0 (2,903.34)
13.2	70 : 15 : 0 (352 34)	6	486 : 0 : 0 (2,420.28)
15.4	60 : 15 : 0 (302.54)	7	417 : 0 : 0 (2,076.66)
17.6	53 : 5 : 0 (265.19)	8	365 : 0 : 0 (1,817.70)
19.8	47 : 5 : 0 (235.31)	9	324 : 0 : 0 (1,613.52)
22	42 : 12 : 0 (212.15)	10	292 : 0 : 0 (1,454.16)

[a] £ = $4.98

Table 2—Comparison (Fuel Costs) of Diesel and Gasoline Engines Based on 60,000 Miles[a]

Gasoline—1s. 2d. per Imperial Gallon (29.1 cents per 1.201 U. S. Gal.) | Gas Oil—4½d. per Imperial Gallon (9.4 cents per 1.201 U. S. Gal.)

Type	Seating Capacity	Tax, Gasoline Engine	Tax, Diesel Engine	Miles per Gal., Gasoline	Miles Per Gal., Diesel	Fuel Cost, Gasoline	Fuel Cost, Diesel	Fuel and Tax, Gasoline	Fuel and Tax, Diesel	Saving on Diesel	Saving per Mile
A.E.C. Regal	32	£57:12:0 ($286.85)	£88 ($438.24)	6.75	13.46	£518 ($2,579.64)	£83 ($413.34)	£576 ($2,868.48)	£171 ($851.58)	£403 ($2,006.94)	1.61d. (3.35 cents)
Leyland Tiger	32	£57:12:0 ($286.85)	£88 ($438.24)	6.72	11.80	£521 ($2,594.58)	£95 ($473.10)	£577 ($2,873.46)	£183 ($911.34)	£396 ($1,972.08)	1.58d. (3.29 cents)
Leyland Titan	48	£76:16:0 ($382.46)	£128 ($637.44)	5.55	8.88	£631 ($3,142.38)	£127 ($632.46)	£708 ($3,525.84)	£255 ($1,269.90)	£453 ($2,255.94)	1.812d. (3.77 cents)

[a] £=$4.98.
In the United Kingdom the tax paid on gasoline is 8d. (16.64 cents per 1.201 U. S. gal.) per Imperial gal. and 1d. (2.08 cents) per gal. on gas oil.

reaches a point of 200 to 250 miles per Imperial gallon it is considered necessary that the cylinder should be rebored or new liners fitted as the case may be.

Fuel consumption with the direct-injection type of engine should be better than with either the rotational-swirl type or precombustion type, as in the direct-injection type there are obviously not the pumping losses which are associated with the other type under consideration. The costs of fuel-pump maintenance may, however, be higher with the direct-injection type of engine owing to the higher fuel-injection pressures necessary with this type.

Table 1 is of interest. It is based on the relative saving on a 50,000-mile basis and compared with the average gasoline engine.

Table 2 gives some interesting figures of costs based on 60,000 miles. There are two types of engine employed; namely, the A.E.C. (separate chamber) and the Leyland type (open chamber).

It will be noticed that the fuel-consumption figure for the A.E.C. vehicle is appreciably better than the Leyland. In view of the writer's remarks earlier in this paper, it will, no doubt, be thought contradictory. A possible explanation of this is that in the service concerned, which involves long distance cross-country runs, the engine speed is high and hence the advantage of the open chamber (direct injection) as regards fuel economy no longer applies.

The maintenance figure quoted by one large operating company for the Leyland types gives a figure of 0.42 cents per mile for gasoline and 0.52 cents per mile for compression ignition; which makes the oil engine 25 per cent higher than the gasoline engine. This figure of 0.52 cents per mile is, in nearly every instance, being lowered as the repair centers become acquainted with oil-engine practice.

Figs. 1 and 2 show curves for comparative fuel-consumptions of the Leyland engine, using gasoline and using gas oil.

Fig. 3 shows the direct-injection system employed by Messrs. Leyland Motors Ltd. The combustion chamber is formed as a simple open cup in the top of the piston. No glow-plug or other auxiliary apparatus is required for starting. The natural movement of the air as it enters the cylinder is used to mix the fuel and, as this flow is orderly and non-reversing, the combustion chamber is entirely free from the heat losses of some of the more complicated systems. The fuel is sprayed toward the piston center and is kept well away from the cylinder walls.

Fig. 4 shows diagrammatically a direct-injection system which illustrates the difference between this system and the one shown in Fig. 3.

Fig. 5 illustrates the rotational air-swirl or separate chamber in which the fuel is injected into a small chamber connected by a narrow passage with the cylinder head. In this

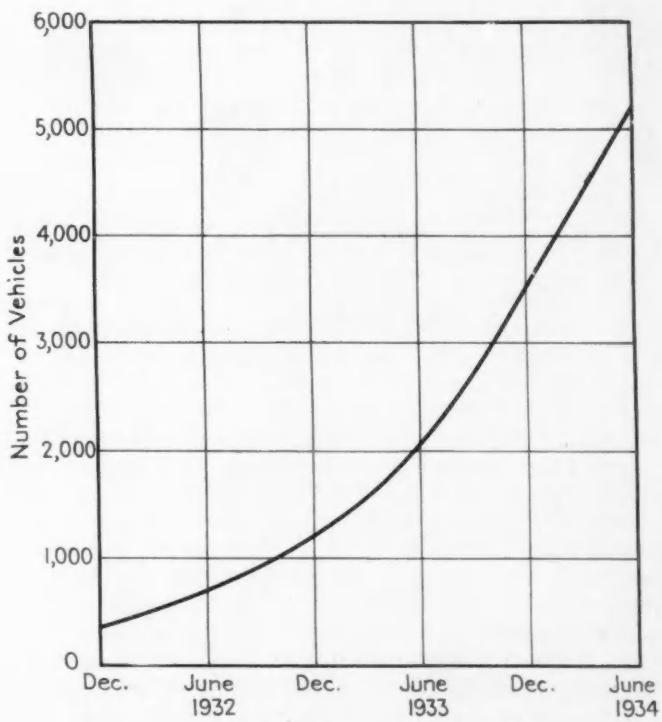

Fig. 6—Curve Showing the Number of Compression-Ignition-Engine Vehicles on the Road in Great Britian

type the air is swept past the fuel nozzle, entering the chamber tangentially and acquiring a rotational motion. This produces very good mixing of the fuel and air.

The curve in Fig. 6 shows clearly the rate at which oil engines are increasing in the United Kingdom. As can be seen, in December, 1931, there were only 328 compression-ignition vehicles operating in the United Kingdom, whereas at the end of June, 1934, there were at least 5245 oil-engined vehicles in use.

The figure given at the beginning of this paper of 5500 vehicles is probably a very close estimate of the actual number of vehicles in use. It has been, however, extremely difficult to get accurate data on this subject and there is a possibility of there being a lag of two or three months. The curve, however, shows that there is a definite and rapid increase in the number of oil engines which are being put into commission at the present time.

The author wishes to thank the London Passenger Transport Board and Messrs. Leyland Motors Ltd. for the information which they have kindly allowed to be published.

Fuel and Oil Economy for the Operator

INCREASED labor costs, codes and standardization of freight and passenger rates are constantly decreasing margins from which profits must come. Operators must seek new avenues for increasing the economy of operation, and it is natural that they turn to the question of how much can be done with the fuel and oil.

Some conception of the magnitude of the business involved may be seen when it is noted that the annual bill for gasoline in the United States is $2,500,000,000 and for oil $250,000,000. This fuel and oil must propel and protect an investment in rolling equipment of the order of $4,500,000,000, saying nothing of the vast amount of money invested in necessary stationary equipment, such as buildings and auxiliaries. It must be remembered that it is extremely important that the fuel and oil not only propel the vehicle but accomplish it with the minimum amount of delays due to breakdowns and overhauls. Shutdowns amounting to only five per cent of the life of the vehicles amount to several millions of dollars in loss of income.

From an average for fifty large cities, based on service-station prices, it may be seen that the portion of the fuel expenditure that represents Federal, State and City taxes increased very rapidly from 1 per cent in 1920 to approximately 25 per cent in 1933. For the operator who purchases tank-car or tank-wagon quantities, the percentage is even larger. The gasoline tax for 1933 was $510,000,000. It is obvious that sufficient tax to finance highway construction and repair is justifiable, but it appears that the lamb has been unmercifully fleeced. Retrenchment is necessary.

Concerning the relationship between air-fuel mixture-ratio by weight and the power and efficiency of the engine, the thermal efficiency increases as the air-fuel ratio is increased until a maximum is reached at about 16:1, beyond which it falls off rapidly. The mean effective pressure or torque decrease rapidly from a maximum at about 12.5:1. The economy curve falls between the two, reaching a maximum at about 14:1, the precise ratio depending on the number of hills and the type of equipment. In hilly country a richer mixture-ratio should be used to avoid excessive gearshifting; whereas, in level country, it is possible to obtain greater economy by using a leaner mixture.

As to the correct mixture-ratios for different kinds of driving for a given vehicle, except for idling, the richest mixture is needed when suction is the lowest, and the least fuel wanted when suction is the highest. Wide-open throttle demands a rich mixture-ratio of approximately 13.5 to 1 for all speeds. This is necessary to give high torque and acceleration with reasonable economy. Idling requires a very rich mixture, due to the poor distribution at very low speeds. As the speed is increased at part throttle, it is advisable to lean the mixture gradually until a ratio of approximately 16:1 is reached. As top speed is reached, a rich mixture is again needed to maintain high speed in rolling country.

During the last few years, several exhaust-gas analyzers have been developed which make it possible to adjust the mixture ratio for maximum economy and excellent performance. There are two general types of exhaust-gas analyzers in use. One type uses the thermal-conductivity method for measuring the carbon-dioxide content of the exhaust, while the other type determines the amount of combustibles by burning these gases completely and measuring the change in temperature brought about by this operation. In either case the exhaust gas is sampled continuously through a tight system to the intake of the exhaust analyzer. Care must be taken to exclude all air and to allow sufficient time for the reading to come to equilibrium. Observations must be taken on the road under actual operating conditions to assure a correct picture. Readings taken under no load are practically valueless, as the vehicle is never operated under such conditions. It is absolutely necessary that ignition and valve timing be correct or the results will be of no value.

One of the factors usually overlooked by operators is the effect of atmospheric temperature on the gasoline mileage. An example of the variation in mileage, from data taken from a bus-transportation-company's files and representing operation in the suburbs of Philadelphia, is that the gasoline consumed at 22 deg. fahr. is 18 per cent greater than at summer temperatures. The increased consumption is due to poorer distribution, more choking and to the practice of allowing the engine to idle at terminals.

The effect of oil viscosity or S. A. E. number is often overlooked, probably due to the fact that oil economy is more easily noted. Recent tests made by Mougey and Wilkin show that oil economy is usually obtained at the expense of the fuel. Some controlled experiments show that 6.4 per cent more fuel is used with an S. A. E.-60 oil than with an S. A. E.-30 oil, and 3 per cent more for an S. A. E.-30 oil than for a 10-W oil. The increased fuel consumption is due to the higher friction with the heavier oils.

There is practically no relationship between fuel mileage and heat content of the gasoline, particularly in the case of petroleum fuels. Comparisons of aviation gasolines—which have a lower heat-content—with motor gasolines, generally show the same mileage. The lower heat-content of the lighter gasoline is counterbalanced by the fact that it vaporizes quicker, thus improving distribution.

Excerpts from a Philadelphia Section Meeting paper by J. C. Geniesse, read Oct. 10, 1934.

An Analysis of Accident Control in Fleet Operation

By J. M. Orr
General Manager, Equitable Auto Co.

SOUND transportation and safety engineering are being successfully applied to accident control, Mr. Orr states, which involves human engineering to a greater degree than in any other phase of fleet management and operation.

After stating accident facts and costs, Mr. Orr presents selected quotations from representative fleet operators and other authorities regarding operating practices, relations with the general public, accident control, future design of highways, driver evaluation, accident-proneness and the like, together with an illustrated description of a portable testing-laboratory for making tests of drivers.

Accident trends in commercial fleets are analyzed, as well as accident aspects in various types of fleets. Other authorities are quoted on various matters relating to training, methods and practices.

In conclusion it is stated that the driver is the most important factor in accident prevention; that the cost of adequate accident-prevention activities is a negligible portion of operating expense; that accidents are increasing; and that present activities are not sufficient to stop the upward trend.

THIS study is based upon the premise that the prevention and control of fleet vehicle-accidents is an operating problem. This is substantially correct; for, aside from the humanitarian aspects involved, fleet operators pay substantially for their accidents in settlement costs, interference with operations, generally lowered fleet efficiency, and the like.

How serious is this problem of accidents? How important is it to the average fleet operator? How much interest, time and effort are being taken and expended to improve present accident experience and arrive at an irreducible minimum?

Upon accepting the assignment to head up this study, I asked a group of the best minds in the country to contribute their beliefs and experiences for inclusion in the report. This group, as will be seen from the accompanying Committee roster, is a representative one, including not only fleet operators but representative psychologists, traffic and safety engineers, accident-prevention managers, State motor-vehicle-department representatives, motor-truck association representatives, and so on. The immediate responses to my request, together with the overwhelming amount and fine caliber of the data and information received, astonished me. They clearly indicate that the subject is a most important one, that it is a costly one, and that it will profitably bear continued study, research and intelligent treatment. I cannot hope, in this report, to do justice to all of the opinion and information submitted to me, but will attempt to make it a representative cross-section.

Sound transportation and safety engineering are being successfully applied to accident control, which involves human engineering to a greater degree than in any other phase of fleet management and operation. We can definitely specify the types of vehicles used, and supervise their maintenance. We can select our operators very carefully, train them, restrain them, and what not, but the fact remains that drivers are self-supervised only, while at the wheel.

Accident Facts and Costs

Briefly, these are the facts. Motor-vehicle accidents killed 31,000 people in the United States in 1933, and it is estimated that from 850,000 to 1,000,000 people were injured non-fatally. The 1933 death-toll rate was higher than in 1932, indicating that the safe-driving remedies applied have not been sufficient to offset the increased use of vehicles resulting from improved business conditions.

In the last ten years, 277,000 people have died and about ten million people have received non-fatal injuries in motor-vehicle accidents. This is equivalent to the horrible thought of slowly but surely killing every person, one every 20 min. for ten years, in a city such as Atlanta, Ga., and the wounding, crippling or maiming for life of every resident in the State of Pennsylvania.

[This paper was presented at the Semi-Annual Meeting of the Society, Saranac Inn, N. Y., June 18, 1934.]

The cost of all 1933 accidents, not including property damage, is estimated by the National Safety Council at 680 millions of dollars. Including property damage, a conservative estimate of total cost is 1½ billions of dollars. These are truly staggering costs for one year's accidents.

According to information collected by a large public utility, the average cost, including that borne by the insurance company and the fleet owner, of an individual accident to a fleet vehicle, is about $200. The total economic loss, including items not paid for by the fleet owner or the insurance company, is estimated at $400 to $500 per accident.

Morris Cohen, industrial engineer of the Schulze Baking Co., reports that a fleet of 472 trucks had 220 accidents in 1933 in the development of almost 8 million miles, for which a total of $21,626 or $98.30 per accident was paid out in insurance settlements alone.

Carl Stocks, editor of *Bus Transportation,* supplies the information that accidents cost the bus companies of New York City 1.47 cents per bus mile or 4.2 per cent of their total revenues in the last half of 1933. Figures taken from the reports of two intercity bus operators indicate that they pay out 5 per cent of their revenues in accident claims and insurance premiums. The cost of accident repairs alone to an intercity bus company operating 844 buses 36½ millions of miles in the year ending June 30, 1933, was $34,107; which is $40 per bus per year or 0.09 cents per mile. These few figures will serve to illustrate the sizable cost of individual-fleet vehicle-accidents.

It is my observation from the facts and from the work of the National Safety Council, State highway-officials, motor-vehicle administrators, insurance companies and fleet owners, that a greater consciousness of our rising accident experience and cost is developing, with a realization that something more must be done about it. Our present efforts are not enough. A definite indication from private-car owners is found in the General Motors 1934 Automobile Buyers Guide, which reports that a majority of 211,000 car owners voted *dependability* as the first, and *safety* as the third general characteristic in order of importance in a motor car. Speed was tenth.

Our future accident experience will depend entirely on whether we really want to reduce accidents, and how hard we try to prevent them. Experience has shown that it is possible to effect reductions when serious efforts are made, through, for example, the education of children, drivers'-license laws, financial-responsibility laws, the efforts of commercial operators, ceaseless safety campaigns and the intelligent enforcement of general laws and regulations.

Accident Significance to the Commercial Operator.—From the humanitarian standpoint, commercial operators have an obligation to minimize accidents and reduce the loss of life, limb and human suffering that follows, not alone in their own operations, but generally. As business men, and as representatives of sizable businesses of character in the communities in which we operate, we are rightfully expected to lend substantial support and impetus to the safer operation of motor vehicles. Our vehicles are industrial tools. We control the uses to which they are put, and we can dictate their method of operation and use.

No commercial endeavor or enterprise can prosper without the good will of its customers and the people in the area served. The establishment and maintenance of good public relations are essential. A bad accident-rate or experience can adversely affect a company's position and standing in the community, and the reverse is equally true.

The operating advantages of a low accident-experience are many, as has been found by operators whose accident frequency and severity are below average for their type of business. Non-productive service-interruption, idle-vehicle time and idle-employees' time have been minimized. Fewer spare fleet-vehicles are required. Insurance costs, or if a self-insurer, adjustment expense and claims paid, are lower. Workmen's-compensation, wage, and welfare payments to injured employees, medical and hospital expenses, accident repairs and extraordinary vehicle depreciation as the result of accidents are lower.

The tangible direct savings possible in an improved accident experience are sufficient to warrant the fleet managers' interest and attention without regard to the intangible benefits.

Are Commercial Vehicles Operated More Safely than Private Cars?—Unfortunately, it seems that when the general public thinks of highway accidents, it thinks principally of transport trucks. National Safety Council reports for 1932 state that, in that year as in former years, four out of five vehicles involved in fatal accidents were private passenger-cars. In New Jersey in 1933, 14 per cent of all registrations were commercial, not including dealer, trailer or bus licenses. Commercial vehicles were involved in 16 per cent of all accidents, and 18 per cent of fatal accidents. When the higher annual mileages developed by commercial vehicles are given consideration, it is obvious that the commercial-vehicle accident-rate is lower than for private cars.

Ted Rodgers is a Scranton, Pa., fleet operator, president of the American Trucking Associations and of his first love, the Pennsylvania Motor Truck Association. The truckers have recognized the importance of safe operation and have been stressing it for several years. Under Mr. Rodgers' direction, the Pennsylvania Motor Truck Association has become the finest in the United States. One of the methods used to combat public reaction against large trucks and to effect safer operation is with the use of their "Three C's" and "The Truck Driver's Ten Commandments." I asked him to comment upon them for this report. He says:

"The 'Courtesy-of-the-Road' tags, issued to members of the Pennsylvania Motor Truck Association, are the insignia by which the passenger-car driver may know that the owner of the vehicle subscribes to the principles of Courtesy—Consideration—Cooperation, the slogan promulgated by the Association in the interest of safe driving.

"My experience has been that truck drivers are just as human as any other class of individuals. They have their loves and their hates, they appreciate the seriousness of damage to life and property, they realize the importance of safe driving to themselves, the perpetuation of their jobs, the peace of their family, and the duty they owe to their employer.

"Believing that drivers could be appealed to on a man-to-man basis, and feeling that such an appeal would result in a substantial reduction of accidents, the Pennsylvania Motor Truck Association promulgated 'The Truck Driver's Ten Commandments.' I have addressed many truck-operators' meetings at which I have always preached highway safety, concluding all talks with a recitation of the 'Ten Commandments.' They seem to catch the fancy of everyone interested in safety. They have been commented upon editorially in newspapers and magazines and have been the subject of numerous articles. They are:

"(1) Always keep to the right side of the highway and pull as far to the right side of the road as possible to allow clear passage for passing vehicles.

"(2) Even though you may have legal right of way, let the other driver have it when appearances indicate possibility of an accident.

"(3) Be especially careful when passing schools or places where children are at play, remembering that the public will condemn you in the event of an accident, no matter how blameless you may be.

"(4) Stop at STOP signs. Most accidents occur at intersections. Stop signs are effective twenty-four hours a day.

"(5) Be especially courteous at times when traffic is unusually heavy, giving every benefit of doubt to operators of passenger vehicles.

"(6) When it becomes necessary to leave your truck unattended, shut off your engine and set your emergency brakes; place in low gear; never stop on curves, at the crest of a hill, or at any point where traffic cannot see your vehicle from all directions; at all times have red lanterns for night, and red flags for day in the event of emergency stops, placing them at least 200 ft. to the front and rear of your vehicle.

"(7) Observe the slogan of the Governor's Committee on Street and Highway Safety—'Take Time to be Safe' and keep 500 ft. apart.

"(8) Take long turns at intersections; short turns often result in accidents.

"(9) Change to low gear from a full stop when about to descend a steep grade; take no chances on your vehicle getting beyond control.

"(10) Difficult as it may be, try to listen quietly when the impatient owner of a passenger car calls you down for some real or imagined discourtesy or infraction of highway regulations. If you are wrong, apologize; if you are right, apologize just the same, and send a report to your headquarters, 316 Telegraph Building, Harrisburg, Pa.

"The 'Ten Comandments' have caught the fancy of the editorial writers because they have a human appeal. They state in simple language what the driver should and should not do to promote safety. They indicate a sincere desire on the part of truck operators to reduce the number of accidents involving trucks on the highways. It is difficult to estimate the results from the dissemination of these 'Ten Commandments,' yet I venture to state that no words written or spoken about safety in Pennsylvania have done more good to the cause.

"Every time these commandments are quoted or commented upon in the press the Association is building up good will for truck operators. It is breaking down some of the ill feeling that passenger-car drivers harbor against the truck on the highway. It is gradually building better public relations for the trucking industry.

"I believe it behooves every operator of a fleet to explain periodically to his drivers the necessity for safety at all times. Safe drivers should be rewarded; careless drivers should be penalized. Some operators make safe driving one of the contingents of promotion and advancement. It is not difficult for a driver to understand that, if he is involved periodically in accidents, he jeopardizes his job and brings distress upon his family as well as upon the families of others. Drivers can be made to realize, if the owner will take time to impress it upon him, that every accident brings criticism against the industry in general and his employer in particular. He can realize further that an accident means higher insurance rates for his employer and other unnecessary expenses, which are directly traceable to the driver's negligence.

"Some of the larger fleet owners maintain training schools for drivers and put every man through a rigorous course of instruction before he is allowed to take a vehicle on the road. Some have safety-conference rooms where drivers and their employers 'reconstruct' accidents and discuss their avoidance. It is obvious that most of the operators are not large enough to engage in such a systematized and detailed consideration of highway safety. Every operator, however, can talk to his men periodically and explain to them the necessity for safe driving, consequences of careless driving and the relationship between good driving and advancement.

"It is my belief that, with the full effectuation of the Code of Fair Competition for the Trucking Industry, safe driving, in so far as trucks are concerned, will receive added impetus. Under the Code, operators are required to pay a certain schedule of wages, observe maximum hours of employment, and adhere to certain trade practices, all of which should operate to build up greater responsibility and more dependable trucking concerns. It is particularly pleasing to note from the figures compiled by the National Safety Council that accidents involving trucks are constantly decreasing. I am hopeful that they will continue to do so, and I am sure they will if all truck operators impress upon their drivers the importance of safety to themselves, to their families, and to their employers."

Factors Affecting Motor-Vehicle Accidents.—The factors affecting motor-vehicle accidents are: (1) The highway, (2) the vehicle, and (3) the driver.

Dr. F. A. Moss, of The George Washington University, famed for the Wobblemeter and his studies on riding comfort, in his response to our request for his views on accident control, sums up these factors as follows:

"(1) *The Condition of the Highway over which the Man Operates.*—An immense amount of work has already been done in eliminating bottle-neck bridges, banking and eliminating curves, and thousands of other things to improve the highway. This is primarily a problem for the civil engineers, and in my opinion they have already reached the point of diminishing returns in that field of accident elimination.

"(2) *The Condition of the Machine.*—This is distinctly a problem of the automotive engineer, and more progress has been made here than in either of the other fields. We have four-wheel brakes, improved tires, improved steering apparatus, better provision for vision, as good lighting as is now possible to construct, and here again I believe that we have reached the point of diminishing returns. There are a few problems that I believe should be investigated, such as: (*a*) Tires, (*b*) ease of handling, (*c*) size of machine, (*d*) carbon monoxide, and (*e*) cab comfort.

"(3) *The Condition of the Driver.*—(*A*) *Licensing the New Driver.*—Practically nothing has been done along this line. Only about one-fourth of the states have drivers' licensing, and in these states the examinations for licensing are totally inadequate. In my opinion, more could be accomplished in this one phase than in any other to reduce the number of accidents. I would suggest the following:

(1) A very rigid mental examination of the pencil-and-paper-test variety.

(2) Individual tests to measure:
  - (*a*) Reaction Time; how long it takes a man to move his foot from the accelerator to the brake
  - (*b*) Vision; visual acuity, peripheral vision, color blindness
  - (*c*) Hearing

(3) Road Tests:
Very rigid road tests should be given to all truck operators. The test should be standardized and should involve problems similar to, but more difficult if possible, than the following:
(*a*) Parking parallel to the curb in a limited space between two automobiles
(*b*) Making difficult sharp turns with the truck in a limited space without running outside the line or hitting the curb
(*c*) Making sudden stops in traffic without killing the engine and the like

"So much for the initial selection of drivers.

"(*B*) *Drivers Involved in More Than One Accident.*—Further studies should be made of those involved in more than one accident to detect if possible whether they have some subtle nervous disturbance such as *petit mal*—a mild form of epilepsy—or some circulatory disturbance that might cause a temporary lapse of consciousness and produce an accident. There are several other factors that would come out in this examination. One study badly needed in this field is the effect of fatigue and loss of sleep in causing accidents. I am firmly convinced from work that I have already done that these are two of the most important factors in the production of the more serious type of accidents.

"(*C*) *Education of the Operators.*—I have often thought that there would be a possibility of reducing accidents, especially by professional drivers, by means of a booklet relating to typical dangerous situations, and methods of getting out of them; or, better still, of not getting into them."

Are Fool-Proof Highways Possible?—Dr. Miller McClintock, director of The Erskine Bureau for Street Traffic Research, in answer to my request for an opinion on the relationship of the reconstruction and future design of highways to accidents, says: "Are fool-proof highways possible?" This question, often the subject of debate when highway engineers or safety directors gather, has but one answer. It is simply "yes."

"Highway safety has become one of our most important national and local problems. It is deplorable, but nevertheless true, that our most efficient mechanical servant, the motor car, is the cause of a yearly death roll of 31,000 men, women and children and that it causes annually serious personal injury to more than one million citizens. This is a matter of concern to every man interested in the automobile industry as well as to everyone who owns and drives a motor car or who walks upon our public streets. We are all striving to make our streets and highways safer. It is a difficult accomplishment.

"Recent studies, attempting to reach the bed-rock of the problem, indicate that an entirely new approach will be necessary. Education of drivers and the punishment of offenders can never afford an adequate solution. The highway itself must be built in such a way that accidents will be impossible. In this we must take a leaf from the history of industrial safety. It will be remembered that the machine age brought danger to factory workers. Men and women were continually losing fingers, toes, eyes and, many times, life itself. A greater cry for safety went up. Factory walls were covered with slogans—'Be Careful'—'Take Care'—'Do It The Right Way'—'Do Not Take a Chance.' No one can say that these slogans were not helpful, but accidents kept on mounting. The flood was successfully stemmed only when accidents were made impossible by guards and protectors placed over dangerous machinery in such a manner that an accident became an impossibility.

"The railways, too, have pointed the way for highway safety. Despite highly trained professionals and refined equipment the country was, for several decades, repeatedly shocked by ghastly train wrecks. Railroad safety was made a reality only when grade separations, block signals, interlocking switches and train-control devices made wrecks practically impossible. The same accomplishment can be had for street and highway safety. Fool-proof highways are possible. They have been made a reality by exhaustive studies conducted by the City of Chicago in cooperation with the Erskine Bureau of Harvard University. These new highways are called 'limited ways.' Their safety features are very simple. Traffic streams moving in opposite directions are physically separated. All intersections are elevated. The 'limited way' has no connection with any abutting property and entrances and exits to it are arranged at convenient intervals by specially designed structures.

"In 1933, there were 900 people killed in the City of Chicago in traffic accidents. An examination of the cause of each of these accidents reveals that only 17 of them would have been possible if all traffic had been moving on 'limited ways.' This seems almost impossible, yet even a brief examination shows the reason. About half of our fatalities are the result of collisions between motor cars and pedestrians. There are no pedestrians on 'limited ways,' and, hence, no pedestrians can be killed on such a structure. The next great cause of fatalities is the collision of vehicles at intersections. This type of accident can never happen on a 'limited way' because there are no intersections. Left-hand turns and other irregular movements in the roadway are further sources of fatal accidents. This cause is practically eliminated by the 'limited way.' In fact, about the only accidents that can take place on one of these structures is a rear-end collision.

"A 'limited way' may be constructed right to the heart of any city, thus affording not only a foolproof right-of-way for automobile operation but, likewise, one which makes it possible to convert our slow, congested traffic streams into economical, high-speed movements. Safe speeds up to 50 m.p.h. to the very center of congestion are reasonably anticipated. A 'limited way' may be constructed either by elevating the main route, depressing it, or by providing a special treatment of an existing surface route. The first method has been selected for the 160-mile system designed for the City of Chicago. By refinements in design it has been possible to estimate that the cost of 'limited ways' may be actually far less than the cost of widening existing streets. The 'limited way' promises not only complete permanent safety but, likewise, promises such greater increase and efficiency that its application will inevitably bring an entirely new era in automobile transportation in metropolitan centers."

Driver Evaluation in the Prevention of Accidents.—Dr. Alvah R. Lauer, associate professor of psychology at Iowa State College, and chairman of the Committee on the Psychology of the Highway of the National Research Council, has developed a fine technique and experience in the application of psychology to the causes of accidents. Dr. Lauer, as a member of this Committee, has contributed to its work in a discussion of "The Diagnosis of Accident Proneness." It follows:

"It is not the purpose of this short discussion to deal with the problems involved in an exhaustive way. Only a few outstanding points will be given relative to accident-proneness.

These are based on six years of study under the auspices of the Committee on 'Psychology of the Highway' for the National Research Council. An outline of the points to be covered is as follows:

"(1) The status of accident-proneness
"(2) What accident-proneness is
"(3) Fallacies underlying the concept of recklessness
"(4) To what extent can drivers be trained to avoid accidents
"(5) Methods developed for analyzing the psychophysical characteristics of a driver: (*a*) Aims and objectives, (*b*) techniques used, (*c*) interpretation of results, and (*d*) using these methods in a constructive program

Comments on Accident-Proneness

"Accident-proneness is a somewhat misunderstood concept. Usually it is interpreted as the psychophysiological condition of the driver which predisposes him to accident. Often it is thought of as an all-or-none proposition. Actually this is not the case. There are varying degrees of accident-proneness and some reasons assigned will be given below.

"Our studies have led to a somewhat different classification than that suggested in the foregoing paragraph. We have found evidence of three groups of drivers; (*a*) the accident-free who constitute from 70 to 75 per cent of all motor-vehicle operators and who never have an accident; (*b*) the accident-liable consisting of about 20 to 25 per cent who have no actual organic or psychic deficiencies but who often overstep their capacity; and (*c*) the accident-prone who have outstanding defects which can be quite easily found. The accident-prone make up some 2 to 5 per cent of the driving population.

"The question might be raised as to the advisability of developing methods for measuring the performance of a minority group of drivers. The answer is obvious: If 7 per cent of drivers were taken off the road, accidents would decrease 50 per cent. As may be noted from the figures given, about 30 per cent of the drivers have all the accidents. More will be said about the relative efficacy of driver training later.

"The Nature of Accident-proneness.—The characteristics of the accident-prone and the accident-liable will next be discussed. There seem to be major and minor susceptibilities to accident. One may have one major susceptibility and have little trouble. His accident rate is relatively low. Should he have a minor susceptibility coupled with the major difficulty, his accident rate may climb rapidly. For instance, a commercial driver we have studied had a good record for several years. He showed performance ability below average. This was a major susceptibility which he could overcome by concentration. Illness of his wife developed. He began having frequent accidents. The particular effect of illness and other conditions at home will vary with the driver; but, in general, it may be said to be a minor susceptibility. Here is a case where two susceptibilities combined to bring on accident-proneness which one alone would not have done.

"The breaking-point or individual threshold which determines the effect of such influences is somewhat related to the neural stability or emotional makeup of the driver. If he is unstable, the threshold is likely to be low. If stable, it may be relatively high. This fact makes any average relationship hard to evaluate. A clinical diagnosis may be 95 per cent correct, while the blind application of performance norms may be only 25 per cent correct. In other words, the measurements must be evaluated in relation to the individual or in relation to each other.

"The accident-liable group are usually quite good drivers but have some bad habits or weaknesses which get them into trouble. This group will profit more by training and a safety-training program will do much to straighten out their difficulties if they are properly diagnosed.

"Recklessness a General Category.—One of the greatest fallacies in accident analysis is the grouping of certain types of accidents as due to carelessness or recklessness. There is no such category. It is a 'catch-all' for those things which are not well understood. A man must be careless in some way. Either he does not look at signs, he turns his head to read advertisements, he starts and stops too quickly, he weaves in traffic, he cuts corners, or otherwise follows some dangerous practice. Poor judgment, due to low intelligence, often is branded as carelessness. If the individual is studied carefully enough, carelessness will usually break down into some more or less specific deficiencies or susceptibilities.

"Can You Train Drivers To Be Safe?—Driver-training programs are much talked about but, actually, little is done. A few formal lectures, some posters, or possibly the manipulation of miniature models usually define the extent of this training. A regular school for the serious study of actual accidents of the company, with a visit to the scene of the trouble, would materially help other drivers who have similar characteristics of the man having the trouble. Motion pictures, charts, individual analysis of the cause of the accident by other employees would do a great deal to avoid mishaps. It is impossible to set down any set procedure on paper. One might as well set down a cut-and-dried scheme for home treatment of pneumonia. The professional training and experience of one trained in the field must be brought to bear upon the situation in hand. The proper training of drivers is as diversified as the number of situations involved. In general it may be said that certain of the accident-liable can be helped a great deal, while others cannot be. The accident-prone group are harder to handle. They profit less by training.

"Making The Tests Practical.—It is proper that some explanations of methods so far developed be given. This will be done in as few words as possible and supplemented by a few pictures. In the first place, the fundamental aim has

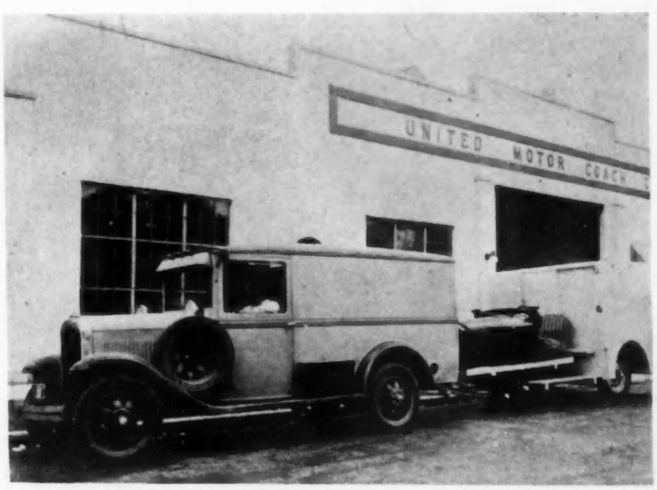

Fig. 1—Truck with Trailer Hitched for Rapid Transportation

been to select measurements which are known to be related to accident-proneness through careful research studies. This is technically known as validity. Next the tests used must measure consistently from time to time. A record made today must be about the same if repeated tomorrow. This is technically known as reliability. Finally, the test must be quick and easy to give. There must be no elaborate preparation requirements which make the administration of the tests impractical. Another important matter is that the individual's performance-rating must be known immediately after he finishes the test in order that he may be classified then and there. In this way the examination will mean much more to him and be more effective. This means careful standardization of the equipment in performance. Also the equipment must be rugged and designed for quick transportation from one place to another. Especially is this true of research apparatus.

"Now to describe briefly the set-up used at Iowa State College: A Fargo truck with trailer hitched for rapid transportation is shown in Fig. 1. The trailer serves as a portable laboratory for use in commercial plants. The truck has three seats for assistants and space for luggage. When on tour, a camping outfit is used to reduce expenses. Figs. 2 to 7 show a few of the separate testing measures used.

"In Fig. 2, the driver begins by giving complete information about his experience, driving record, personal record, and data relating to social status. He is then checked for color vision by the Ishihara test and for field of vision by the Nuchols Chart. The dynamometer is used to measure strength. In Fig. 3, blood-pressure measurements are made by an objective test, recording the pressure automatically. Blood pressure is one index of physical condition. In Fig. 4, speed of movement is measured by a telegraph key and electric counter. The 10-sec. interval is timed by means of a small synchronous motor.

"In Fig. 5, visual acuity is measured by the Clason Acuity Meter. The phorias are determined by means of a Stevens Phorometer used in connection with a phoropter head. The astigmatic index is measured by dividing the visual acuity of one meridian by that of the other. The larger is used as the denominator, giving an index less than unity.

"Tests of susceptibility to glare are made with and without tinted glasses, as shown in Fig. 6. Further studies are being made on methods for measuring the effect of glare. The stereoscope is used to make preliminary tests of visual acuity, stereopsis and the phorias. Any deficiency is referred to the Clason for more exact diagnosis. Ocular dominance is also measured.

"In Fig. 7, the driver is measured for susceptibility to shock stimuli by the galvanometric technique. This device has been used by J. H. Lahy in Paris to test men for bus and street-car operation. The telephone is used to give the subject directions and to ascertain the validity of certain statements made in the first interview. These are later verified by the company's records. The booth is located in the back of the trailer.

"Fig. 8 shows the driving apparatus in action. The driver is seated at the wheel and his performance is noted by the examiner who sits beside him. Brake movements, clutch movements, shifting, control of the car, and time required to make the trip, are registered automatically by counters in the box near the front wheel. When traveling, the front wheels are carried in the cabinet.

"Only a part of the separate tests is shown and described here. Others include tests of strength, reaction time, observational ability, intelligence, mechanical aptitude, and the like. Other measurements are being incorporated as our research progresses. The clinic has been taken to Des Moines, Iowa, Chicago and Detroit. Plans are on foot for a 3000-mile trip this summer. The research project becomes a cooperative venture through which we secure research data at the same time that companies derive the benefits of examinations of their drivers. It should be added that statistical analysis is made of large groups of drivers and conditions of the test carefully standardized. Percentile graph curves are used for immediate interpretation of scores made. The driver is given a rating of himself in the form of a profile chart showing his strong and weak points."

With the foregoing as a background, and as general justification for our attention to this situation, let us examine it particularly as a problem of fleet operation. Accidents are unnecessary and wasteful. We are impatient at the necessity for treating their consequences when they do occur. We are reluctant to accept accidents as a necessary and normal part of fleet operation. Yet to suppose that fleets can be accident-free, except for a comparatively short period, is impossible, and even though commercial drivers were perfect, or nearly so, in every hazardous situation encountered they are bound to become involved accidentally with people and other vehicle operators who are less skilled, less alert and perhaps heedless of the potentialities of motor cars and trucks as instruments of death and destruction. So what are we doing about it?


Fig. 2—Driver Giving Information about His Experience

Accident Trends in Commercial Fleets

In the United States, from 1927 to 1933 inclusive, private-car operators involved in fatal accidents have increased about 40 per cent, whereas truck operators have declined 2 per cent, bus operators 25 per cent and taxicab operators 45 per cent. Motor trucks constitute 13½ per cent of all motor vehicles and are involved in 17 per cent of all fatal accidents, which is probably due to their annual mileage being higher than that developed with private cars.

Commercial-vehicle fleets reporting to the National Safety Council for the year ending June, 1933, had 3.04 accidents per 100,000 miles operated. Table 1, taken from "Accident

Facts—1934," shows the wide variation between types of vehicles and businesses.

Table I—Accident Rates of Commercial Vehicles, July, 1932, to June, 1933[a]

Groups	No. of Vehicles	No. of Vehicle Miles (Thousands)	No. of Accidents	Rate[b]
All Fleets	39,298	583,405	17,746	3.04
Passenger Car	691	9,531	248	2.60
Bus	2,478	110,451	3,266	2.96
Intercity	1,136	67,680	701	1.04
City	1,342	42,771	2,565	6.00
Commercial Trucks	36,129	463,423	14,232	3.07
Petroleum	10,208	150,434	2,989	1.99
Intercity trucking	331	10,042	210	2.09
Miscellaneous manufacturing plants	335	4,571	99	2.17
Ice	276	2,537	60	2.36
Transfer and storage	265	3,897	96	2.46
Other light delivery	200	3,489	87	2.49
Public utility	12,130	128,561	3,556	2.77
City and intercity trucking	509	9,237	263	2.85
Bakeries	2,046	30,304	957	3.16
Dairies	1,087	13,435	431	3.21
Meat packing	731	10,708	407	3.80
Beverages	501	5,080	208	4.09
Laundries	1,337	16,628	702	4.22
Coal and Ice	1,208	11,401	544	4.77
Building materials	146	1,730	87	5.03
City trucking	2,047	20,827	1,081	5.19
Department Stores and other retail delivery	1,512	23,066	1,290	5.59
Newspapers	570	11,001	715	6.50
Fuel	690	6,475	450	6.95

[a] Source: individual company reports to the National Safety Council.

[b] The rate equals the number of accidents per 100,000 vehicle-miles.

Discussion of Accident Aspects in Various Types of Fleets. —Type of Operation an Important Element.—In considering the application of measures to control fleet accidents, the type of operation is an important element and should be considered in planning a program. For the purpose of this discussion, commercial fleets are divided into four types:

A—Public-carrier fleets, used to transport passengers for hire

B—Fleets used in delivery service for the transportation of property and commodities

C—Fleets used for transportation by technicians, salesmen, collectors, and professional people, where driving is an incidental part of the job

D—Employee-owned cars and trucks used in company business

Type "A"—Public-Carrier Fleets.—Public-carrier fleets usually have the lowest accident record. There are several primary reasons, which also apply in varying degree to other types of operations.

(1) Safe operation is a basic requirement for any good transportation service, and is so recognized by every public-carrier executive. Consequently, safety commands executive support.

(2) Safe operation is a selling point for the service.

(3) Because safe operation is basic, the executives who operate these fleets give safety primary attention and consideration.

(4) Personal injuries to passsengers carried result in enormous claim losses, which can seriously affect earnings, destroy patronage, and decrease the efficiency of the service.

(5) The actions of the drivers of these fleets are constantly under observation by passengers. This stimulus alone minimizes careless acts on the part of operators and in a degree it amounts to constant supervision.

(6) Public carriers usually employ inspectors or road foremen, whose duty it is to supervise the drivers on the road, not only for the general efficiency of the service, but also for safe operation.

(7) Public-carrier fleets operate over established routes. Drivers become familiar with the hazards and operating conditions existing on the routes, and develop an operating technique to meet these conditions not possible in other types of transportation service where the routes are not fixed and are subject to constant change.

Type "B"—Commercial Fleets—Delivery and Trucking.—The operation of these fleets does not involve injuries to passengers, and claims do not involve the extensive monetary losses faced by public carriers. There are usually no road foremen or inspectors, and road supervision is not comparable with that in public-carrier fleets. Supervision is usually limited to that at terminals. A large number of these fleets is made up of small operators who give scant attention to preventive safety. They purchase insurance from year to year and are apt to feel that they have thus fulfilled their safety obligations to the public. Their insurance rates are relatively much lower than public carriers. Obviously, the accident problem in this type of fleet does not engage the attention of management in the same degree as with public carriers.

Type "C"—Incidental Fleet Driving.—In this type of fleet, the possession of the ability, or lack of ability, to correctly and safely operate a motor vehicle is a secondary consideration. The men who operate vehicles are assigned to their jobs, not because of driving proficiency, but because of some other primary special ability; as a salesman, technician, or the like. Driving is an incidental part of the job. Although employees may be supervised in their primary work, they are seldom if ever supervised as vehicle operators. Selection of men is not made on the basis of driving ability, but because they

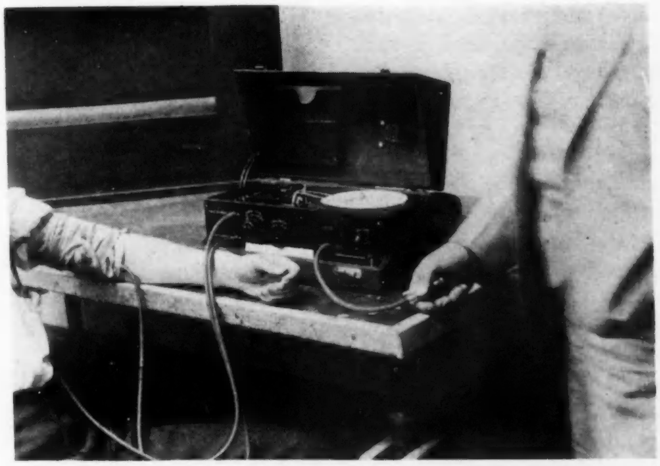

Fig. 3—Blood-Pressure Test of a Driver

are good technicians of some type. Discipline for driving faults and errors is difficult to apply. This class of drivers does not usually feel the necessity for safe and correct vehicle operation to the same extent as do employees to whom driving is their means of livelihood. Methods adopted to improve accident experience must be carefully developed to fit each situation and applied tactfully. Safety programs are more difficult to administer in fleets of this type than in the preceding types. The management's support of accident-prevention work must be constant and substantial.

Type "D"—Employee-Owned Automobiles and Trucks Used on Company Business.—This class, perhaps, is more

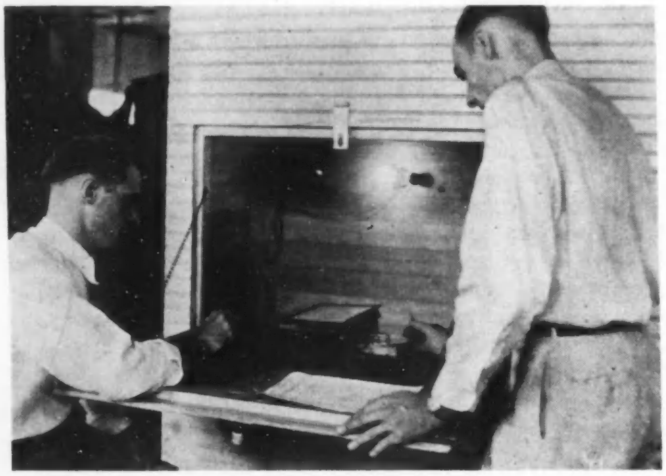

Fig. 4—Measurement of a Driver's Speed of Movement

beyond the control of the executive than any other type of operation. These men buy and pay for their own automobiles and usually their own insurance. Reimbursement is made by the employing company on a time or mileage basis. Employee-owners have a very definite personal incentive to operate their vehicles carefully and minimize costs of operation. Accident frequency is usually low with this type of vehicle.

Type "A" Fleets—Methods of Approach

Driver Selection.—Drivers for public carriers are selected on the primary basis of driving ability. They must demonstrate ability to drive correctly, safely and at the same time maintain scheduled speeds. Selection is limited to men meeting exacting physical and mental specifications. Physical examinations, mental tests, psychological and reaction-time tests are used successfully as aids in selection. The experience of the particular operating company is usually used to establish standards for types of men who can qualify, and they are rigidly adhered to.

"Examining Applicants for Driver's Licenses" is the title of a 30-page manual only recently released by the National Safety Council that should be most helpful to fleet operators in the selection and training of drivers. Prepared under the supervision of the Safety Council's Committee on The Driver and approved by The Eastern Conference of Motor Vehicle Commissioners, it represents the best generally used practices for examining applicants for driving privileges. This manual should be in the hands of every fleet operator. It can be obtained by sending, I believe, 25 cents to the Council headquarters in Chicago. The tests outlined therein for the driving demonstration are substantially the same as those given for several years by the Philadelphia Electric Co., from which company Roy M. Godwin, Director of Safety, comes as a member of our Committee.

Driver Training.—Drivers are given a regular course of training to fit them properly for the job. Re-training follows at intervals as may be found necessary, or as is indicated by man failure. Annual or semi-annual check-up of physical and mental qualifications is a desirable requirement, particularly as it refers to eyesight and hearing.

Isolating and Re-training Accident-Prone Operators.—Fleets engaged in this type of operation find it advantageous to maintain records to measure each man's daily performance. This may be done with a record that shows hours worked or miles operated each day, and the recording thereon of the number and kind of accidents in which the operator becomes involved. The number of hours or miles per accident can be computed for each man and compared with the accident rate of an entire group. Worse-than-average operators are treated as the circumstances warrant, which may include a physical examination, mental tests, re-training, or observation under actual road-operating conditions. The tests may be conducted on a vehicle especially equipped with apparatus to record reaction time, jerky operation, and other factors. Some companies have drivers sign a record for each accident in which they are guilty of contributory negligence. This record gives the facts of each accident and sets forth in detail the driver's fault or failure. When a certain number of such charges, for instance three, accumulates in a certain period, the driver automatically dismisses himself from the service.

Study of Accident Causes.—It appears to me that little could be gained by a discussion of the usually accredited accident causes in this report. The types of accident most serious in fleet operation are "intersection," "backing," and "struck while parked."

J. P. Bickell, Registrar of Motor Vehicles in the Province of Ontario, Canada, suggests from his experience that causes of accidents might more properly be listed as: thoughtlessness, inattention, distraction, fatigue, ignorance, and the like. There is considerable merit in this suggestion, because the operation of a vehicle can be safe or unsafe at the will of its operator. Most accidents are due to a driving fault, lack of attention to the job in hand, or the non-observance of some fundamental rule of safe driving.

A proper type of accident-report form is most necessary. In too many cases, the accident-report form has been designed by the claims agent or the insurance adjuster, and built for him to secure information with which to adjust or defend claims successfully. It is rare indeed where the operating man has had an opportunity to make the accident-report form a vehicle to guide him or the accident-prevention manager in discovering the faults of men and equipment. Accident-report forms should be designed not only to fit the needs of the claims agent, but also the operating official. The form should contain questions pertaining to operating practice, arranged so that it is most difficult for the driver to color the facts or to avoid telling all of them.

Cooperation of the Claims Agent.—Successful accident-prevention work depends upon a knowledge of the facts. Too often serious operating violations do not become known, because all the facts are not recorded in the accident report, and if the accident happens to be one of minor consequence

so far as personal injuries or property damage is concerned, no investigation by the claims agent follows. Accidents causing minor injuries or damage are just as important from an accident-prevention viewpoint as are serious ones. In fact, a serious accident may involve no violation, or a very minor one, while a minor accident may involve serious violations. The claims agent can assist the operating man to find operating faults by inquiring into the cause of all accidents, even though it be by written inquiry upon witnesses, in cases where such action would not jeopardize the interests of the company from a claims standpoint.

Summaries of accident investigations should be forwarded by the claims agent to the operating head, placing him in possession of information to guide him in taking proper corrective action. The claims agent can assist in engaging and maintaining the interest of executives in accident prevention by keeping them informed of the cost of settlements. The complete cost of accidents should be entered against the driver's record and form a part of the measure of his competency. These records will give the operating man an index of the relative severity of accidents in which each driver may become involved.

Compilation and Use of Accident Facts and Statistics.—Records should be so maintained that information can be readily assembled to make group studies of accidents by types, develop information on accident-prone men, peak-location points, effect of road and weather conditions, type of equipment involved, and other factors. Study of individual driver's records may reveal certain careless tendencies. Peak-location points may reveal dangerous conditions upon which suggestions can be made to municipal authorities for traffic signs, lights, curb cut-backs, and the like. Information on type of equipment involved may show defects in vehicle design that contribute to accident cause. Accident records may be used as the basis for monthly and annual reports to executives, as well as to stimulate drivers and maintain their interest.

Rewards for Safe Driving.—It is a moot question as to whether drivers should be given special recognition and awards for safe operation. Some operators feel that safe operation is a measure of competency and that it is rightfully expected of an efficient employee. Henry Dakin, Superintendent of Buildings, Motor Equipment and Supplies, Michigan Bell Telephone Co., expresses himself as follows on this question:

"In our work, a man may be hired to install or repair telephones and he is provided with an automobile to assist him in doing this job, in which event the automobile becomes just another tool, and inasmuch as he is taught to use his screw driver and hammer properly, it is our opinion that he also should be taught to operate the motor vehicle with the same degree of skill.

"In the preparation of the training course for our operators, we have prescribed methods and practices which assist in the safe and proper operation of motor vehicles and call attention to the courtesies of the road as well as the precautions for the safety of persons and property of both the Company and others. We also specify methods which will aid in the efficient and economical operation of the vehicles. After this course of training is given the operator by his supervisor or authorized instructor, he is examined by an inspector from the motor-equipment department and, if passed, is given a card entitling him to operate the particular type of vehicle he is examined for.

"We do not encourage bonuses or other special awards for safe driving, but in our training we point out that the safe operation is a part of the job for which the operator is paid."

Public-carrier and trucking fleets are more likely than others to acknowledge unusually good individual records with certificates, plaques, medals, and cash bonuses. In my own opinion, I believe that the operator of a motor vehicle faces far greater hazards in his daily work than do other employees.

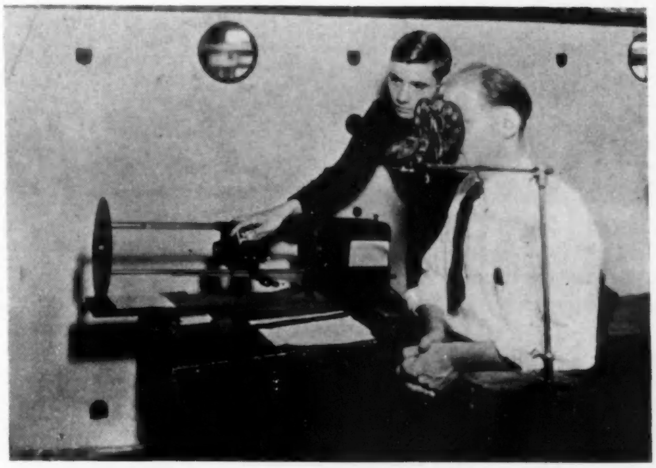

Fig. 5—Measurement of Visual Acuity

He must be mentally and physically alert at all times while at the wheel, and all well-over-average or outstanding good driving records should be adequately recognized and rewarded in suitable fashion.

The National Safety Council has a comprehensive plan of stimulating interest and granting awards for safe driving that many fleets are using successfully. Many insurance firms maintain an individual-award service for their assureds. Based upon its Silver Fleet experience, the B. F. Goodrich Co. instituted its effective and result-producing Silvertown Safety League. In its first two years, more than 750,000 individual drivers pledged themselves to drive safely, acknowledging their pledge by displaying an emblem on their cars. About a year ago they expanded this laudable service by establishing a safety award plan for commercial operators in which 3657 fleet owners and 47,189 of their drivers are now participating. Goodrich is reaching the small operators as is evidenced from the fact that the average number of drivers per fleet is 13. In the first year of this commercial plan 1424, or 39 per cent of the fleets enrolled went six months without an accident and 221, or 6 per cent went 12 months without an accident. Fourteen thousand three hundred and sixty-eight or 30 per cent of the drivers enrolled went 6 months without an accident, and 2844 or 6 per cent drove 12 months safely.

It is difficult to put a cash value on safe driving except on primary driving-jobs. Rewards to incidental drivers almost have to be planned upon a non-monetary basis. This can be done, as is shown by the results that are being secured in endeavors such as are outlined above.

Driver Education.—In addition to the training and retraining of individual operators, the bulletins and Safe Practices Pamphlets of the National Safety Council are available, and to this may be added home-made bulletins, pamphlets, motion pictures, and the like. Mass meetings are used by many fleets.

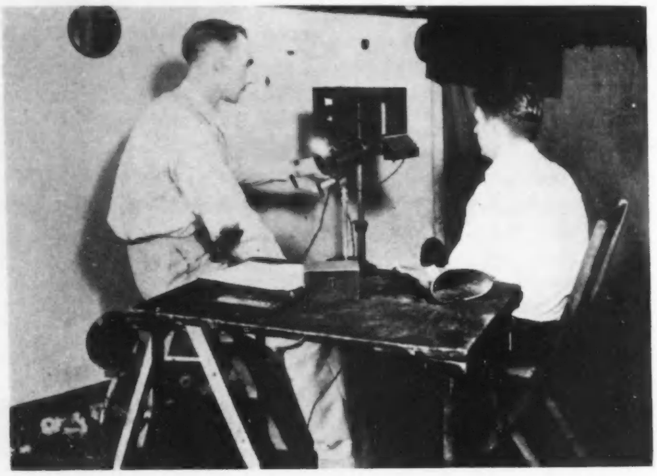

Fig. 6—Tests of Susceptibility to Glare

Type "B"—Commercial Delivery and Trucking.—All items outlined for public-carrier-type fleets may be used with equal success by fleets of this class. One of the difficulties sometimes experienced is in the lack of interest by executives, due no doubt to the fact that accidents and claims losses are low in number, amount, and comparative importance, as a result of which they receive little attention unless particular emphasis is placed upon them for some reason. The first task that the man in charge of accident prevention usually faces is to sell his own operating executives on the necessity and value for a balanced accident-control program. He may do so by presenting comparative figures showing the performance of his own fleet with those of other companies engaged in similar work. The cost and frequency of accidents should be emphasized. The loss ratio, that is, the ratio of claims losses to insurance-premium cost, should be compared with other fleets and with the National Average. Argument can be used that insurance costs are based on experience and that large losses mean large premium costs. Accidents injure employees, destroy public good will, cause damage to property, disable equipment, and interfere with fleet usage and efficiency. An intelligent presentation of facts to the management should win support in the application of many of the applicable remedies suggested.

Type "C"—Incidental Fleet Driving.—While many of the corrective methods given above may be applied to this class of fleet, difficulty is experienced because men are not hired and supervised as drivers. Also, because driving is incidental, management does not have the same relative interest in the accident problem that exists with public carrier and delivery fleets. The management must first be sold; then standards established whereby men are required to rate satisfactorily in physical and mental tests and an examination of driving ability before being permitted to operate fleet vehicles. Much of the same plan outlined for full-time drivers, such as in bus operation, could be applied to this group, with the exception that it is more difficult to administer discipline. In the allocation of fleet costs to operating departments, it might be possible to graduate vehicle charges to reflect the claims losses of each department. This would surely engage the attention of the operating man and induce him to supervise and discipline incompetent or careless drivers.

Accident Committees.—Accident Committees, or Company Traffic Courts, made up of operating supervisors and key men, are used extensively by all types of fleets to consider specific fleet accidents and accident trends. The committees act as fact-finders and investigators of specific accidents. Drivers appear before them, responsibility is determined and recommendations for disciplinary measures are made to department heads or executives, for whom they act as assistants and advisors. Department heads, by some method, should review all accidents participated in by employees under their direction, and should lend full support to the accident-prevention manager in administering a program. Executives should insist upon a uniformity of compliance throughout given organizations, particularly large ones.

Many of us have observed the good results obtained through intelligent and effective accident committees. A recent instance is reported by Harold E. Oszman, superintendent of transportation of the Northern States Power Co., who is securing gratifying results in his fleet. The interest and enthusiasm of vehicle operators were aroused by posting individual driver's accident records in each division, comparison of standing with other divisions, and the determination of accident facts, responsibility, and discipline for errors by accident committees of fellow-employees. Mr. Oszman states that this plan has set up a competitive rivalry among drivers that is effecting a substantial reduction of accidents.

Type "D"—Employee-Owned Cars and Trucks Used in Company Business.—Employee-owners are most likely to be careful drivers and become involved in few accidents compared with drivers of company vehicles. The reasoning is obvious. They drive their own property, which in itself is an incentive of direct financial interest. Their driving habits are properly subject to supervision during the use of their vehicles on company business, because of their employer's legal and moral responsibility, possible claims losses, and the unfavorable public reaction against the employer when vehicles are improperly operated by employees in the conduct of his business. Many of the remedies already discussed can be applied to employee-owners.

Factors that Affect the Possibility of Accidents

The National Safety Council reports that in 1933, 7 per cent of the motor vehicles involved in fatal accidents were reported defective in some particular. Of this, 2½ per cent had defective brakes, 2 per cent improper lights, and ½ per cent had defective steering mechanism. This does not show the full extent of mechanical failures due to some vehicles being damaged too badly to identify defects and the unwillingness of live drivers or the inability of dead ones to admit them.

Harold G. Hoffman, Commissioner of Motor Vehicles for the State of New Jersey, states that their records over the past few years indicate that 6 per cent of New Jersey accidents are caused by defective mechanism of cars or faulty road construction.

The Committee on Motor Vehicle Maintenance of the National Conference on Street and Highway Safety estimates that defects contribute in 15 per cent of all accidents.

In commercial fleets, the percentage of mechanical defects contributing to accidents is low. In the Oklahoma Gas and Electric Co., for instance, H. R. Grigsby, superintendent of transportation, informs us that in the past 2½ years there have been only three accidents in 9½ million miles of operation that could be attributed to mechanical defects. Mr. Grigsby's fleet had an accident frequency during the period of 1.215 compared with a national average of 2.42 accidents

per 100,000 miles in public-utility operations, taking first honors in the National Safety Council Fleet Contest.

For the purpose of this discussion, we must assume that fleet vehicle-maintenance practices are adequate, treating only those physical and mechanical factors that seem to be of most importance.

Frequent and careful inspection is apparently one of the cheapest methods of minimizing accidents. Vehicles must be inspected periodically to insure of their being in fit condition for the service to which they are assigned. This should never be slighted, and, if it is, either as to scope or time interval, maintenance costs, accidents, accident repairs, and claims losses will increase.

Brakes, steering, lighting, horn, windshield, windshield wiper, and similar vital equipment should receive very close inspection and attention. The State of Pennsylvania compels each owner to submit his vehicle to a semi-annual inspection, and repair, if necessary, of vital equipment.

Following accidents, however slight, in which mechanical defects are alleged, a thorough examination should be made to determine the fault, if any, and apply corrective measures.

Tires are now very dependable. Their design and manufacture have advanced rapidly in recent years, and they are responsible for fewer and fewer accidents. On the other hand, the best tires made can be grossly misused and contribute to the possibility of accidents.

W. C. Bray, manager of the truck and bus tire department of The B. F. Goodrich Rubber Co., reminds us that tires usually fail suddenly and without warning, as compared to mechanical failures. He continues:

"A few years ago, large fleet operations were confined to restricted areas. Buses, trucks and passenger cars are now operated over larger areas. Some operators are gradually striving for higher scheduled speeds and, as a result, experience premature tire failures, probably due to poor selection of tires and tubes, overloading, underinflation, use of improper-size rims, and poor tire maintenance. Many tire manufacturers have introduced features in their product to prevent the destructive action of heat in the carcass of the tire. They have designed special bead constructions which have practically eliminated bead trouble and most all of them have improved their traction, which goes a long way toward safer transportation.

Other operators are on slower schedules, but their vehicles are ordinarily subjected to severe operating conditions due to road conditions and severity of routes traveled, and oftentimes by heavy overloading. These conditions have a tendency to cause premature failures farther down in the carcass of the tire, in the region of the beads and flippers. It is therefore important, in the selection of tires for this kind of an operation, that the operator give serious consideration to proper sizing of tires.

Most premature tire failures are due to blowouts, principally due to overload, underinflation, or high sustained speeds. Overload can only be corrected by properly tiring a vehicle or properly restricting its load. In respect to underinflation, most fleet operators recognize the advisability of maintaining regular inflation inspection, both in garages or terminals and while the vehicles are on the road. Regarding blowouts directly due to high tire temperatures, this can be greatly minimized by proper studies of each individual vehicle and its operating conditions. It is necessary that vehicles be adequately tired, adequate air pressure maintained, sustained road speeds governed as much as possible, sufficient brake-drum clearances provided, and as much ventilation as possible given, particularly to the rear wheels.

We have learned very definitely from our experience on bus lines the value of preventive tire-maintenance. The dual matching of rear tires should be watched closely and governed to meet road conditions encountered. For example, on extremely highly crowned roads, tires having considerable tread design remaining should be placed on the outside and well-worn or smooth tires on the inside dual positions. If this cannot be accomplished, a somewhat greater air pressure than normal can be used in the outside tire to equalize the load. This procedure has a tendency to increase the amount of rubber in contact with the road, prolonging tire life, and giving additional traction and safety.

Tires should be regularly inspected for cuts and injuries which might develop into failures while the vehicle is on the road. It is usually better to apply new tires on the front wheels and use slightly worn tires on the rear.

Chains are an essential safety device in automotive operation. Their use has been the means of avoiding many accidents. They should be a fixed part of the equipment of a vehicle, available to operators not alone for winter hazards but for mud that is apt to be encountered at almost any time by work cars and trucks. The make and type used should be chosen carefully, with correct application to various types of tire and wheel equipment. There is one caution regarding the use of chains. Drivers have been known to rely too much upon them to preclude skidding, particularly on ice. One of the large oil companies does not allow the use of chains in the San Francisco area, because in the foggy season streets are very slippery and drivers take risks with them that they do not take without them.

The gross-weight capacity of vehicles should be observed in their loading. Appreciable overloads decrease the factor of safety of brakes, tires and springs, and invite trouble. In a

Fig. 7—Measurement for Susceptibility to Shock Stimuli

desire to get maximum load-space capacity many big trucks are poorly arranged for safe operation.

Winch and hoist levers are, in many cabs, placed in such a manner and position as to crowd and hamper the operators unduly. Cabs lack good vision, seats and lazy backs are placed improperly with reference to instruments, foot and hand levers and the steering wheel. Cabs are generally uncomfortable, inducing fatigue quickly, upon the heels of which accidents follow.

Proper load distribution is important as it effects roadability and maneuverability. Front-end stability can be varied greatly by the manner in which trucks are loaded. We have all seen trucks with long loads overhanging the rear end of their bodies, or with all of the load in the rear end, most of it behind the rear axle. Malpractices such as these decrease the degree of driver's control and increase the possibility of accidents. The transference of weight to the rear axle with improper loading is apt to be astonishing to those who have not given it particular attention. Faults of this type are in no way due to the inherent design of a vehicle, but to its improper usage.

The presence of carbon monoxide in cars or trucks can lead to very serious results. It is possible for this deadly gas to accumulate to a serious extent in a car following another at usual trailing distance as well as from its own defects or poor combustion efficiency. Tests conducted by the Travelers Insurance Co. clearly demonstrated that a dangerous concentration can, and often does, exist and that this fact may have a substantial bearing upon the frequency and severity of automotive accidents. The Travelers Co. tests were made on vehicles that passed along a Connecticut highway. Included therein were cars and trucks, both privately and fleet operated.

Clinton Brettell, superintendent of garages of R. H. Macy & Co., tells us that a spot-check was made of certain of their trucks by an outside agency and that only negligible amounts of carbon monoxide were found in the cabs. Combustion efficiency was tested at the same time and found high, offering tangible proof that in fleets maintaining combustion efficiency within high practical working limits, carbon-monoxide dangers are negligible.

What Can Commercial Operators Do To Reduce the Number and Severity of Fleet Accidents?—They can provide the most modern, adequate and efficient vehicles possible for the work to be done. Safety should be engineered into the selection of chassis and cabs and the design of bodies.

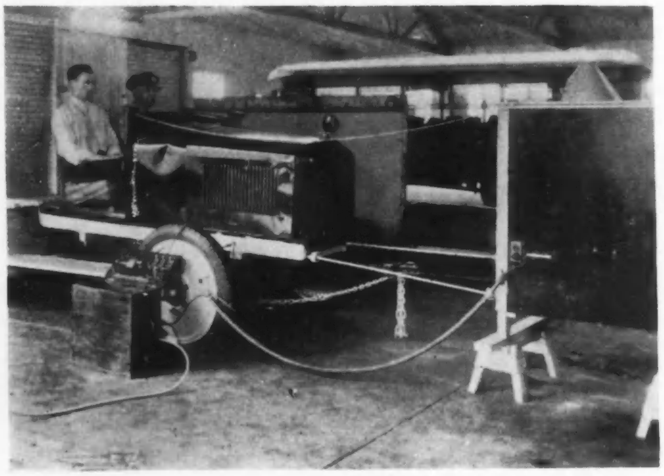

Fig. 8—The Driving Apparatus in Action

At the instance of Leonard V. Newton, automotive engineer, Byllesby Engineering and Management Corp., I raised the question as to whether cabs can be too comfortable. He feels that more driver fatigue is caused by illy designed uncomfortable seat cushions and lazy backs than any other one truck-design factor. He refers to Packard's exhibit in recent automobile shows of the form of an average individual compared with the contours of the Packard seat and back. To quote Mr. Newton: "If we accept the size and dimensions of the Packard seat cushion and back as the shape and size necessary for the average individual, and compare them to the seats and lazy backs in the average truck, we can draw but one conclusion, that is, the Packard is all wrong or else there has been no engineering done in truck cabs. I am inclined to believe that the latter is true."

Sidney J. Williams, Director of the Public Safety Division of the National Safety Council, in answer to the question says: "No. I have the definite conviction that it is not good policy to try to keep a driver awake by making him uncomfortable. On the contrary, the more comfortable we can make him, the more energy and attention he will have for his job." On the subject of sleeping cabs Mr. Williams says, "Where two drivers undertake to drive a vehicle for a long distance we feel quite strongly that this practice should not be permitted unless the sleeping arrangement is equivalent to a Pullman berth; otherwise, the 'sleeping' is a farce and drivers operate practically without sleep, which is a serious hazard."

Dr. Moss says that a study of the effect of fatigue and loss of sleep in causing accidents is badly needed. I personally feel that cabs cannot be too comfortable and that this consideration for our drivers is necessary and desirable.

There is a danger in vehicle speeds that are too low to be accommodated safely to modern traffic requirements. Some accidents can be rather definitely attributed to this fact. Maximum allowable road speeds have been stepped up, with limits in some states removed entirely, and it would not be surprising to see minimum-speed limits fixed for major highways.

Performance ability of trucks deserves careful consideration. In comment, Arnold H. Vey, traffic engineer for the State of New Jersey, considers this to be of vital importance, based upon experience in his state, where roadways are quite heavily congested by mixed vehicular traffic. He says, and we all agree with him: "Commercial vehicles should have sufficient motor power to permit reasonable speed performance on normal grades. This is a difficult subject insofar as national uniformity is concerned, because equipment that would be entirely adequate in some of the flat mid-western states would be entirely inadequate in mountainous states."

The unusual economic conditions of the last several years have precluded the normal replacement of many trucks that, while ample to perform at top speeds considered safe at their time of purchase, are now woefully unable to match the pace of traffic and new truck equipment. Speed is relative. A speed of 40 m.p.h. on the open highway is usually safe, while 25 or 30 m.p.h. can be definitely unsafe in certain types of congested districts. Governors and other devices can be used to limit the top speed of vehicles, and it has been found that they not only reduce accidents but that they are good insurance against excessive maintenance and higher operating costs that follow top-speed operation.

Proper headlighting is important. A study of the many good papers presented in meetings of the Society leaves one with the impression that there is much to be desired in head-

light design from an operating standpoint. There is a distinct need for a headlight that can be kept on bright with a low beam and that will not cause a glare to approaching vehicles.

Good cab vision, adequate and reliable windshield wipers, ample rear-vision mirrors, stop and clearance lights, good signalling ability, and the like, should be provided in fleet vehicles.

Vehicle manufacturers can give commercial operators real assistance in the prevention of accidents by careful study and treatment of the design factors that make for safer operation.

Conclusions

During the development of this report, I was asked what conclusions we were going to be able to draw from it. We could draw many of them, but this appears to me to be the type of paper in which conclusions are too apt to be anti-climaxes. Beyond saying that the driver is the most important factor in accident prevention; that the cost of adequate accident-prevention activities is a negligible portion of operating expense, or perhaps of one serious accident; that accidents are increasing and that present activities are not sufficient to stop the upward trend, we prefer that any conclusions to be drawn be of your own choice.

In the individual opinions of the Committee members the most serious aspects of present day accident trends are:

(1) That there are too many incompetent and irresponsible drivers on the road who are disregarding common-sense rules of safety, traffic control systems, and the like. The need for driver education, adequate driver's licensing laws and uniform traffic regulations is plainly seen.

(2) That unfit and unsafe vehicles should be cleared from the roads, probably by compulsory inspection requirements.

May I express my personal gratitude to the members of this committee for their enthusiastic participation and fine contributions to its work. I am indebted to each one of them.

"Accident Control in Fleet Operation" Committee

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Motor-Vehicle Taxation Continues To Increase

As a result of the onslaughts that have been made upon it by those who would over-regulate it or tax it to the extreme limit of its ability to pay, the motor vehicle today is carrying a load of taxation far beyond its just share of Government cost. Last year the 23,827,000 registered motor-vehicle owners of this country paid $1,318,872,000 in motor-vehicle and gasoline taxes, and, of this amount $301,932,039 went for State and municipal registration fees, $518,195,712 for State gasoline taxes, $181,000,000 for Federal gasoline taxes, $247,744,425 for excise taxes and $70,000,000 for personal-property taxes. The highway user alone paid more than one-eighth of all the taxes collected.

Motor-vehicle taxes have increased 300 per cent since 1919 and yet the motor-tax curve continues to swing upward, despite the many indications that taxes on motor-vehicle owners have passed the point of diminishing returns in several states and are having a retarding effect on highway transportation generally. The situation has reached a point where, in short, the future of the great automotive industry, employing, as it does, 10 per cent of the gainful workers of the country, and the future of the allied industries, such as, for instance, the petroleum industry, hinges largely on the degree to which highway transportation can be freed from the shackles of unfair, burdensome and discriminatory taxation.

The motor-tax bill for 1933 was about 33.8 per cent greater than that of 1930, and this during a depression, in which taxes should be reduced, rather than raised. The motor-vehicle tax-bill is being collected through 19 different levies, 6 of which are special Federal levies and 13 are special taxes imposed by State, county and city governments.

On the basis of the total motor-tax bill for 1933, the average motor vehicle last year was taxed $50.47, an increase of $12.75 per vehicle over 1930. At the current rate of taxation the average motor-vehicle owner is taxed 26.7 per cent of the value of his property, and, in the course of seven years, which is the average life of an automobile, he pays in taxes 186.9 per cent of the value of his property. He also pays a sales tax of 43 per cent for gasoline on the basis of the retail price.

Freight-carrying vehicles compose only 14.8 per cent of all the motor vehicles registered, yet they are paying in registration fees 25.12 per cent of all public revenue. Notwithstanding all this, there are some who contend that the trucks are not paying their share of taxes.

—Excerpt from a paper entitled "The Trend in Taxation and Regulation of Highway Transportation," by Gen. H. B. Markham, read at the Regional Transportation and Maintenance Meeting, Newark, N. J., Nov. 8, 1934.

Propane and Butane as Motor Fuels

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ALTHOUGH considerable information concerning the properties and merits of propane and butane as motor fuels has been available, most of it has not sufficiently covered the economics of their supply, availability and price. Therefore, the authors present typical data obtained by their use.

Subsequent to an analysis of the sources, properties, advantages and heating values of propane and butane, two sets of test data comparing these fuels with gasoline are submitted and commented upon. Further data obtained in actual road-operation under load are presented also, together with a discussion of the economic factors which includes comparisons with gasoline as fuel.

Production and distribution problems are considered, as well as the most feasible applications of propane and butane. The authors conclude that, for highway use, their cost per gallon delivered to the fuel tank will generally be as high as, or higher, than the price of regular-grade gasoline.

THE use of liquefied petroleum gases, particularly propane and butane, as fuels for internal-combustion engines, while not a new development, so far as their application to stationary engines is concerned, is comparatively recent as applied in significant volume to mobile engines, as in buses, trucks and trains. While these fuels unquestionably have a number of outstanding advantages over other fuels for large stationary-type engines, the extent of these advantages for mobile engines is limited largely by the type of service to which the vehicle is to be put, and upon a number of important economic factors. Recent literature has contained considerable information concerning the properties and merits of propane and butane, and many claims have been made of their advantages over gasoline and other fuels. Most of this literature, however, has not sufficiently covered the economics of their supply, availability and price. In the final analysis, these are to be the most important factors governing the future use of these gases on the highways and must be given very careful consideration.

In order that a better understanding may be had of the reasons underlying the present interest in these fuels, a brief review is presented which includes some typical data which have been obtained by their use.

Propane and butane are the principal liquefied petroleum gases commercially available. They are obtained from two principal sources; from natural gas in the production of natural gasoline, and from refinery gases formed in the refining of petroleum. Products from the latter source contain propylene and butylene in addition to propane and butane. These gases are members of the same families of hydrocarbons which predominate in gasoline, but differ in that they are gases under standard conditions of temperature and pressure and are liquefied under pressure to concentrate their thermal value for economical transportation and storage. Propane and butane are shipped as liquids in specially designed tank cars, under their own vapor pressures, which vary with their temperatures. The vapor pressure of typical commercial propane at 70 deg. fahr. is 124 lb. per sq. in. gage, and that of commercial butane 30 lb. per sq. in.

Since these fuels are handled in liquid form, they are sold on a gallonage basis in commercial quantities, making their heating value per gallon an important property when comparing them with other liquid fuels. Table 1 shows the heating values on a weight and volume basis of propane, butane, and several liquid fuels.

It has been demonstrated on numerous occasions that propane and butane have a number of potential advantages over liquid motor-fuels arising, first, from the fact that considerably higher compression-ratios can be used with them than with gasoline; and second, from the completely gaseous form in which they are fed to the carburetor or gas-air mixer, resulting in thorough mixing of the fuel and air and uniform

Table 1—Heating Values of Propane, Butane, and Several Liquid Fuels

Fuels	B.t.u. per Lb.	B.t.u. per Gal.
Commercial Propane	21,600	91,500
Commercial Butane	21,200	102,600
Aviation Gasoline (70 deg. A.P.I.)	21,000	122,650
U. S. Motor Gasoline (60 deg. A.P.I.)	20,750	127,600
Kerosene (42 deg. A.P.I.)	20,000	135,000
Diesel Oil (25 deg. A.P.I.)	19,000	142,000

[This paper was presented at the Regional Transportation and Maintenance Meeting, Newark, N. J., Nov. 9, 1934.]

distribution of the gas-air mixture to the engine cylinders. The octane number of propane is 125 and that of butane 93, both greatly in excess of premium grades of antiknock gasoline now available. This means that compression ratios as high as 10 to 1 with propane and 7 to 1 with butane can often be successfully used if the engine construction is rugged enough to stand the higher cylinder-pressures obtained. If full advantage is taken of these higher pressures, considerable increases in power output and thermal efficiency are obtained, together with additional advantages with which automotive engineers are doubtless acquainted as accompanying the use of high compression-ratios. However, it is very important to note that when propane, butane, and gasoline are used in the same engine at the same compression ratio, no material difference in their power output is generally observed and fuel consumption in terms of British thermal units is about the same. The reason for this, it is apparent, is that the volumetric efficiency with gasoline is higher than that with the gases, due to the cooling effect of evaporation of the liquid fuel in the engine cylinder. Propane and butane, on the other hand, are vaporized in the fuel tank or in separate heat exchangers and enter the mixer as gases, with the opportunity of absorbing heat in their travel to the cylinders. This heating effect can be kept at a minimum by controlling the amount of heat furnished to the vaporizer and by locating it as close as possible to the gas-air mixer with insulated lines between.

The other principal advantages offered by the liquefied petroleum gases result from the more accurate proportioning of fuel and air over the entire throttle range, and uniform distribution of the mixture to the cylinders. Thus, greater improvement over gasoline is noted at high and low speeds than at moderate speeds, due to the difficulty in getting uniform distribution of the liquid fuel at these speeds. Better mixing of the gaseous fuels assures more complete combustion, which, in turn, usually results in a substantial decrease in oil consumption and carbon formation, and a considerable reduction in the quantity of noxious gases formed in the products of combustion.

The best operating results to date in mobile equipment have generally been attained with heavy trucks and buses, tractors, and construction and road-building equipment, operating much of the time on full throttle. Light trucks and buses have usually shown about the same or lower mileage per gallon with propane and butane as with gasoline. Such data as are available from the limited number of applications to passenger cars indicate a uniformly lower mileage with the gaseous fuels. The fact that liquefied petroleum gases do not have wide distribution in the small quantities desired also greatly limits their application to this type of vehicle.

To illustrate better the comparative performance of propane, butane and gasoline, two sets of test data are presented. The first, shown in Table 2, covers a number of dynamometer tests on a well-known make of bus-type engine, at various compression ratios under carefully controlled conditions. The engine used was a six-cylinder, valve-in-head engine having a 4-in. bore, 5-in. stroke, and piston displacement of 377 cu. in.

The fuels used in the foregoing tests were commercial grades of propane and butane and a regular grade of commercial gasoline, having a specific gravity at 60 deg. fahr. of 0.725 and an octane rating of 61. Table 2 shows comparative results obtained with butane and gasoline, at a compression ratio of 4.38, with butane at a compression ratio of 6.75, and with propane at a compression ratio of 9.95. These ratios were the highest obtainable in this engine with these fuels, without detonation. In the case of propane, the maximum compression-ratio was limited by the ability of the engine to withstand the higher explosion pressure. It will be noted that, at the compression ratio of 4.38, gasoline and butane developed practically the same maximum horsepower. The specific fuel consumption in pounds was slightly less with butane than with gasoline, but the gallons of fuel used per brake-horsepower hour was 0.131 in the case of butane as against 0.108 in the case of gasoline.

Power Comparisons

At the high compression-ratios considerably greater power was developed with propane and butane, and the specific fuel consumption by weight in the case of the liquefied petroleum gases was considerably less than with gasoline at the compression ratio of 4.38. However, fuel consumption in terms of gallons of fuel consumed per brake-horsepower hour was practically the same in the case of all three fuels, at the maximum compression-ratio obtainable with each. Table 2 brings out very well the true story in the comparison of these fuels; that the gallons of fuel consumed per brake-horsepower hour is usually about the same, when each is used at the maximum compression-ratio obtainable with it, and that when the ratio of the engine is not raised, the consumption of propane or butane in terms of gallons per brake-horsepower hour is generally somewhat greater than the corresponding consumption of gasoline. This is, of course, due to the higher British thermal-unit value per gallon of gasoline over that of liquefied petroleum gases. Further evidence is here offered that the greatest advantage to be derived from the use of propane and butane is in the increased maximum power which can be developed with a given engine, if higher compression-ratios are used.

Table 3 helps to complete the picture by presenting some data obtained in actual road-operation under load. This series

Table 2—Comparative Test Results Obtained at Full Throttle with Propane, Butane and Gasoline on a 4 x 5-In. Six-Cylinder Bus-Type Engine

Fuel	Compression Ratio	Maximum Hp.	Average Specific Fuel Consumption, Actual Test Data: Fuel, Lb. per B.Hp.-Hr.	Average Specific Fuel Consumption, Actual Test Data: B.t.u. per B.Hp.-Hr.	Volumetric Fuel Consumption, Gal. per B.Hp.-Hr.	Octane No.
Propane	9.95	99.0	0.458	9,920	0.108	125
Butane	6.75	86.8	0.512	11,000	0.107	93
Butane	4.38	66.0	0.630	13,545	0.131	93
Gasoline	4.38	63.4	0.663	13,517	0.108	61

Table 3—Propane versus Gasoline Performance Data

Fuel Used	Compression Ratio	B.Hp. and R.P.M.	Gross Weight of Tractors, Trailers and Load, Lb.	Average, M.P.H.	Average, Miles per Gal.	Fuel Used, B.t.u. per Ton-Mile per Hr.
Propane	5.5 to 1	Unknown	68,370	24.0	2.73	4,060
Gasoline	4.35 to 1	89 at 2,500	68,640	18.0	3.67	4,640

of tests was made on a G.M.C. T-60 pulling a semi-trailer and a four-wheel trailer. The semi-trailer weighed 8500 lb. and had a nominal carrying capacity of 22,000 lb. The four-wheel trailer weighed 8290 lb. and had a nominal carrying capacity of 15,700 lb. The total gross weight of the tractor and loaded trailers was 68,370 lb. In these tests, only propane and gasoline were used. It is reasonable to believe that, at the same compression ratio (5.5 to 1), the fuel consumption with butane would have been about the same in terms of British thermal units as with propane.

The standard compression-ratio of this engine for use with gasoline was 4.35 to 1. A higher compression-ratio of 5.5 to 1 for use with propane was secured by planing down the head. The net result in these road tests was that the fuel consumption in British thermal units per ton mile per hour was less in the case of propane than in the case of gasoline; but, due to the lower heating value per gallon of the former, the average was 2.73 miles per gal. in the case of propane as against 3.67 miles per gal for gasoline.

It is apparent that, from the standpoint of truck or bus operation, relative fuel cost of the liquefied petroleum gases and gasoline will be almost directly proportional to the price per gallon of the respective fuels delivered to the vehicle fuel-tank. It is important, of course, to keep in mind the operating savings possible from decreased oil consumption and reduced engine maintainance generally accompanying the use of the gaseous fuels, in addition to the potential increase of power available—if compression is raised—for making grades and hauling heavier loads.

Having covered in a rather brief manner some of the operating characteristics of the liquefied petroleum gases as vehicle fuels, we will proceed to a discussion of the economic factors of supply, availability, distribution costs, and price of these fuels, which are so important in defining their proper field of application. In arriving at an estimate of the potential supply of propane and butane in this country, Table 4 is presented.

It is necessary to consider two sources of supply, one the natural-gasoline industry, the other the refining industry. It has been estimated that there is a daily gross potential production of about 10 to 13 million gal. of liquefied petroleum gases from the natural-gasoline industry. This large supply is not, however, immediately available. The design and operation of the average natural-gasoline plant is such that only a portion of the potential supply is extracted along with the raw natural gasoline, and its production is economically accomplished only at the larger plants. The amount of liquefied petroleum gases removed from the natural gasoline in preparing it for the market is in excess of 1½ million gal. daily, of which 50 per cent is propane. Possibly 50 per cent of this immediately available supply exists at plants too small to justify economically the equipment necessary for the further separation of liquefied petroleum-gas products; this leaves a current available supply of about ¾ million gal. daily.

The potential butane production of 59 major refineries east of the Rocky Mountains is estimated to be 4 million gal. per day, based on the recovery of 95 per cent of the butane which is present in the refinery gases. Here again, however, the potential supply is not all immediately available. Today's gasolines average about 5 per cent butane, so at least one-half of this potential butane supply is required in motor fuels, and, in general, refiners probably will not make the investment necessary to render the whole volume of the potential available. Moreover, during the winter, gasolines with a butane content of 9 per cent or higher are frequently encountered.

The combined propane capacity of the same 59 refineries, based on 25 per cent recovery, is approximately 800,000 gal. per day. There are many reasons to believe that the butane content of most motor fuels may gradually increase in the future. With such a trend, it appears probable that the refining industry will utilize all of its own butane supply, which already has been paid for in raw-material form. Although certain refiners do have an excess supply of butane over present motor-fuel requirements, it is, in many cases, a temporary situation, and of seasonal nature. Most refiners will hesitate to sell butane for other uses if it is worth more as a constituent of motor fuel. Neither will they be likely to make the investment necessary to produce butane if it is to compete with their main product, gasoline.

For purposes of comparison, there is shown also in Table 4 the total marketed production of refinery and natural gas-

Table 4—Potential Supply of Propane and Butane in the United States

	Gallons per Year
Potential production of liquefied petroleum gases from the natural-gasoline industry	3,650,000,000
Liquefied petroleum gases extracted in the manufacture of natural gasoline	547,000,000
Current available supply of liquefied petroleum gases from the manufacture of natural gasoline	273,500,000
Current available supply of propane from the manufacture of natural gasoline	136,750,000
Current available supply of butane from the manufacture of natural gasoline	136,750,000
Potential butane production, 59 major refineries east of the Rocky Mountains	1,460,000,000
Portion of potential butane used in gasoline on the basis of 5 per cent butane-gasoline	730,000,000
Potential propane available from refineries	292,000,000
Total propane currently available	428,750,000
Total butane currently available	866,750,000
Total propane and butane currently available	1,295,500,000
Total gasoline marketed in 1933 (Bureau of Mines Report, 1934)	17,107,818,000

oline during the year 1933, as taken from the Bureau of Mines report. It can be seen that the available supply of liquefied petroleum gases, while amply large to take care of all industrial requirements, and for use as internal-combustion-engine fuel in certain cases where they are particularly applicable, such as in railcars and other railway demands and tunnel and construction locomotives, would fall considerably short of taking the place of gasoline as a universal automotive fuel.

For a number of reasons, it is possible that propane will take precedence over butane in future developments. In the first place, as already explained, a large portion of the available butane is desirable in motor gasoline, to which it imparts volatility and antiknock properties and in which it commands a higher price than as a separate gas; whereas, most of the large potential production of propane must be used as a liquefied petroleum gas, or as a refinery fuel. The higher octane number of propane makes it possible to go to even higher compression-ratios with this fuel than with butane. Furthermore, propane is usually self-vaporizing, having an initial boiling-point often as low as 52 deg. below zero fahr., as compared with an initial boiling-point of 12 deg. fahr., and an end point of 32 deg. fahr. or over for a typical commercial butane. With butane it is generally necessary to use a vaporizer for converting the fuel from the liquid to the gaseous state, while propane in many installations can be withdrawn directly from the top of the fuel tank as a gas.

The cost of transportation and handling of the liquefied petroleum gases is perhaps the greatest factor controlling their delivered price as compared to gasoline in less than tank-car quantities. Because these fuels must be stored and handled under pressure, all storage and handling equipment must be designed for higher working pressures than corresponding equipment for handling gasoline. This means a considerably increased investment in high-pressure equipment. To illustrate this point, let us examine some comparative figures.

In the first place, we are considering two different liquefied petroleum gases, propane and butane, propane having a pressure at 70 deg. fahr. of approximately 124 lb. per sq. in. gage, and butane a vapor pressure of about 30 lb. per sq. in. at the same temperature. However, many producers and users make a practice of constructing all storage and handling equipment of sufficient strength to hold propane pressure, so that it will be interchangeable with either fuel. The regulations of the National Board of Fire Underwriters provide that the minimum designed working pressure for butane storage-tanks shall be 80 lb. per sq. in. gage and, for propane storage-tanks, 200 lb. per sq. in. gage. Table 5 gives some idea of the comparative costs of certain types of equipment normally used in the handling and distribution of motor fuels. These values are representative of present quotations on new equipment.

Table 5—Comparative Costs of Equipment Normally Used in the Handling and Distribution of Motor Fuels

Fuel	Installed Cost	Fuel Capacity, Gal.	Fuel Capacity, in Million B.t.u.	Fuel Cost per Gal.	Fuel Cost per Million B.t.u.
Storage Tanks (30,000-gal. water-capacity; complete, with fittings)					
Gasoline	$1,250.00	29,500	3,764	$0.042	$0.33
Butane	4,500.00	26,330	2,701	0.171	1.67
Propane	7,000.00	24,750	2,265	0.283	3.09
Tank Cars (Complete)					
Gasoline	$2,000.00	8,000	1,021	$0.25	$1.96
Butane	4,000.00	9,655	991	0.41	4.04
Propane	6,000.00	9,075	831	0.66	7.22
Tank Trucks (Including fittings and including pump on liquefied-petroleum-gas trucks)					
Gasoline	$2,600.00	1,000	127	$2.60	$20.47
Butane	3,500.00	500	51	7.00	68.63
Propane	4,000.00	500	46	8.00	86.96

Dispensing Equipment

Gasoline (Including 500-gal. underground storage tank and dispensing pump installed at service station)	$285.00
Propane and butane (To date we know of only one installation of dispensing equipment for butane similar to the service-station dispensing-equipment used with gasoline. Cost estimated.)	$950.00

Utilization Equipment

To convert a gasoline engine for use with liquefied petroleum gases would necessitate supplying a high-pressure fuel-tank with necessary fittings, and a heat exchanger, pressure regulator and mixing valve or carburetor. The total cost of this equipment would vary with the type used and the capacity, somewhere between $100 and $250. This is exclusive of the cost of changing compression ratio.

Cost Considerations

The figures in Table 5 do not represent the total equipment or cost necessary in the handling of liquefied petroleum gases from producer's plant to the automobile fuel-tank, but the items listed are examples of the increased investment required. Furthermore, any replacement of gasoline with these fuels would mean the junking of present gasoline equipment, which is already available in surplus quantities. The tank-car freight-rate per gallon on liquefied petroleum gases is the same as that on gasoline, but on a British-thermal-unit basis is considerably higher. In some methods of distribution the fuel is shipped from central bulk stations to utilization points in high-pressure cylinders, and it is apparent that the ratio of tare weight of cylinders to the gas content is high, resulting in a delivery cost per gallon considerably higher than that of gasoline.

It is apparent that in order for propane or butane to deliver in small quantities to the truck or bus operator at a rate equal to that of gasoline, the price f.o.b. at the refinery will have to be considerably less than the gasoline price. Such a condition has existed in the past in some locations, particularly on the Pacific Coast, where excess quantities of propane and butane had for some time been available at numerous natural-gasoline plants and refineries as a by-product and where it was serving no other purpose than as a plant fuel. As a consequence, the price quoted on it was very low and many of the users were located within not more than 150 to 200 miles of the producing plant, making their delivery cost also low. This unusual price situation no doubt was a large factor in the early, rapid expansion of the use of these fuels in automotive engines. However, as the consumption of these fuels has increased, their price in small quantities has been gradually increasing, with a consequent reduction of the price differential between them and gasoline. When the demand has reached a point where it absorbs the excess supply, it is necessary for the producer to make an additional investment in order to produce additional quantities of propane and butane.

When this happens, these gases are no longer by-products, but must be charged with a higher manufacturing cost.

During the earlier use of these fuels, the State and Federal gasoline taxes did not apply, which, of course, greatly increased the price differential between them and gasoline. At present, however, the Federal Government and practically all States in which they are used to any extent in motor vehicles have placed these fuels when used for this purpose in the same class as gasoline.

An examination of the comparative prices now being quoted in California will be of interest. Last year, when the use of butane as a motor fuel on the highways was just getting under way, prices as low as 3 cents per gal. f.o.b. at the refinery were quoted on butane in l.c.l. quantities and a number of long-term contracts were made on this basis. At present, the major refiners in this section are quoting 6.5 cents per gal. f.o.b. at the refinery on butane, as against a current quotation for 54-58 U. S. Motor Gasoline for intra-state shipment of 7 to 8 cents per gal. and for out-state shipment of 6.5 to 7.5 cents per gal. f.o.b. at the refinery. Thus, at present quotations, the refinery price of the two fuels per gallon is about the same and the price in the vehicle fuel-tank probably would be higher for butane, considering the higher cost of transportation and handling of the liquefied-petroleum-gas product. It also should be noted in this connection that the refinery quotations on 54-58 U.S. Motor Gasoline in California are considerably higher than the refinery quotations on third, or even second-grade gasolines in other sections of the country. To illustrate this point, we have listed the refinery tank-car quotations on U. S. Motor Gasoline of 62 octane number and below at points in the United States as taken from the market section of the *National Petroleum News* of Oct. 24, 1934. These prices were effective Oct. 22, 1934.

Oklahoma	2.875-3.25
Western Pennsylvania	6.00 -6.25
California	7.00 -8.00
Kansas	4.00 -4.125
North Texas	3.75
West Texas	3.00 -3.50
East Texas	2.625-2.875
North Louisiana	3.00
Arkansas	3.00
Ohio	6.875

Current tank-car quotations on propane and butane at Eastern producing points run from 5 to 10 cents per gal. f.o.b. at the source, depending upon grade. Because of the low temperatures often developed by vaporization and gas expansion in some parts of the fuel system, it is necessary to use bottled-gas grades of commercial propane which have a moisture content considerably less than that of ordinary industrial grades.

At present it appears that propane and butane offer greatest advantages as motor fuels in large stationary engines for the operation of generators, pumps, and other industrial equipment; in high-speed railcars and rail trains; and in switching, tunnel and construction locomotives. In all of these applications high power-output per unit of engine weight is a very important factor and full advantage can be taken of the high cylinder-pressures obtainable with these fuels. Engines of this type are running much of the time under full load and are usually of large size, and the fuel-distribution problem is often a serious one when liquid fuels are used. These applications also permit handling the fuel in large quantities and at relatively few points, so that the cost of distribution is very much lower than would be the case were it to be supplied in small quantities to large numbers of smaller highway units and be available at many service locations.

New Development Possibilities

The recent advent of high-speed streamlined air-conditioned trains and railcars offers possibilities of utilizing very efficiently the advantages of propane. Vaporization of the propane produces refrigeration at a suitably low temperature-level, which is available for air cooling. It further provides a convenient and economical fuel for engine-driven lighting-generators, heating of the passenger section in cold weather, and as fuel for buffet stoves and diners. The gas storage at terminals is also available for numerous power generating and heating purposes there.

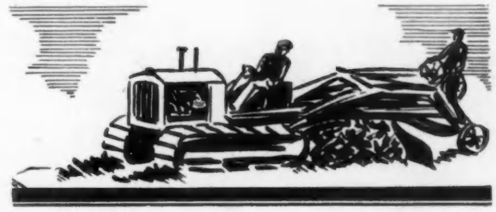
The Southern Pacific Co. has operated a number of gas-electric railcars on butane for the last two years, attaining a 33 1/3 per cent increase in horsepower output from the engines over previous gasoline operation (compression ratio raised from 3.62 to 5.96) and a marked reduction in oil consumption and running and shop repairs.

Butane-powered locomotives are being used on the Colorado River Aqueduct construction-work being carried on by the Metropolitan Water District in California. The conversion of the 8-ton Plymouth locomotives from gasoline to butane included raising the compression ratio and has resulted in faster and smoother acceleration and a 25-per cent increase in power. Tests run on the exhaust gases from these locomotives have shown only very small percentages of carbon monoxide, and it is considered possible that they may be substituted for electric locomotives in the tunnels in the future.

No discussion of the use of liquefied petroleum gases would be complete without some mention of the safety considerations involved. It must be recognized that the handling of these gases by vehicle operators on the highways represents a greater safety hazard than the handling of gasoline, since most operators have never had any previous experience in the handling of gases under pressure. That this fact is recognized is evidenced by the regulations which have already been promulgated in some parts of the country, covering the use of these fuels on the highways. Regulations are now being prepared by a number of other national and state regulatory bodies with the proper purpose of guiding this development in the line of best safety practice. Compliance with such regulations will, of course, have an important bearing upon insurance rates on vehicles and on buildings in which they are kept.

In conclusion, it appears that the most logical applications of liquefied petroleum gases are in types of service definitely requiring increased horsepower output and where large quantities of the fuels can be handled at relatively few service points. For highway use, their cost per gallon delivered to the fuel tank will generally be as high as, or higher, than the price of regular-grade gasoline. Operators considering their use in this service should investigate carefully the economics of cost and availability, and the requirements of regulatory bodies which have jurisdiction.

Tractor Group



Talks Engine Wear at Chicago

ATTENDANCE at this second National Tractor and Industrial Power Equipment Meeting went well over the 300 mark, recording more than 50 per cent increase over the first gathering in Milwaukee last April.

New projects for the standardization and research divisions of the Society were suggested as a result of discussions about piston rings, cylinder wear, air cleaners and other topics.

AROUSING a degree of enthusiasm equal to and perhaps even greater than that attending the first gathering held in Milwaukee in April, the second meeting under the auspices of the National Tractor and Industrial Power Equipment Committee of the Society of Automotive Engineers, held at the Hotel Stevens in Chicago, Dec. 5-6, proved itself so valuable that at its conclusion members and guests joined in a unanimous vote favoring even more vigorous development of this activity in the future. The referendum was informally taken under the direction of C. G. Krieger, agricultural engineer, Ethyl Gasoline Corp., Detroit, chairman of the Committee, to assist in guiding the Committee in laying plans for the future. After two days of hearing splendid talks and profitable discussions of papers, there was no question that the activity is considered very much worth while in helping to solve the problems confronting engineers in the tractor and industrial power field.

The meeting was held virtually upon the first anniversary of the Chicago conference of last December, which resulted in creation of the Committee. It followed immediately upon a two-day meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers, many members of which remained over to participate in the S.A.E. meeting. A fine spirit of cooperation was evident, growing as the meeting progressed. As expressed by John A. C. Warner, secretary and general manager of the S.A.E., at the outset, this cooperation is not a "new deal" but an old deal, recalling the cooperative effort of 1925 and earlier. Similar sentiments were expressed by the president of the A.S.A.E., G. W. McCuen, head of the department of agriculture, Ohio State University, Columbus, responding to Mr. Warner's welcome. He said that while the fields were somewhat overlapping, the distinction is that the automotive engineer designs and builds the machines which the agricultural engineer applies. Mr. McCuen expressed appreciation of the compliment paid him by the Committee in inviting him to serve as chairman of one of the sessions.

The theme of the meeting may be summed up as "What Causes Engine Wear and What Can We Do to Minimize It?" A surprising store of valuable information was uncovered throughout.

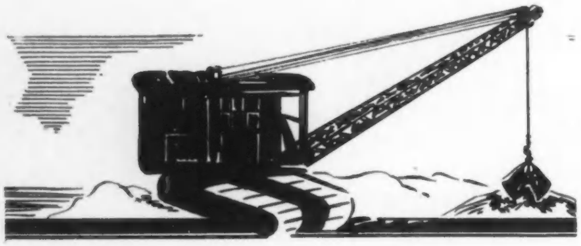
Pistons and Cylinders at Opening Session

With Frank W. Curtis, research engineer, Kearney & Trecker Corp., Milwaukee, machine tools, in the chair, the first session concerned cylinders and pistons. Cylinder bore surface and shape characteristics were discussed in a paper by Kirke W. Connor, president, Micromatic Hone Corp., Detroit, who proceeded along the line that it is a well known fact that the cylinder assembly parts of an internal combustion engine deteriorate at a much more rapid rate than any other of the component parts.

"The theory of corrosion as being of relatively greater importance than abrasion is substantiated," Mr. Connor said, "by the experience of most marine engine builders as compared with motor car and tractor manufacturers. There is very little, if any, dust or grit drawn into the marine engine and the higher rate of cylinder wear is quite likely due to over-cooling, afforded by the facilities at hand during operation. Again substantiating the corrosion or erosion theory, we know that air compressor cylinders, as well as refrigerator units, show relatively little wear and it is thus evidenced that the products of combustion must have their effects. Inasmuch as speed does not seem to be a contributing force to the wearing property, as concerns erosion or etching of the surface and due to the fact that no difference in wear is apparently due to the use of either aluminum or cast-iron pistons, it is a fair assumption that localized cylinder wear might be caused by erosion at the points of blow-by due to cylinder bore distortion.

"It is suggested that the degree of finish be taken into consideration when combating the effects of corrosion, for it has, in general practice, been found that a smooth surface sets up a greater resistance to wear, not only of itself but it imparts the same effect to other contacting parts and, in this respect, smooth cylinder walls have, of course, contributed to increasing the life of piston rings. Some time ago it was contended that smooth cylinders prolong the breaking-in period of new engines. However, in the case of at least

Digests of the papers presented at this meeting appear on pages 23 and 24 of this issue.



one Diesel engine manufacturer, comparative tests revealed that engines with honed cylinders came up to compression in 45 hr. of running, whereas with the previously used reamed finish, 200 hr. of breaking-in time was required. At the same time, the cylinder wall wear was reduced from seven and one-half ten-thousandths in 24 hr. and one and one-half thousandths in 50 hr. to no indicated wear in the same period of operation when using honed cylinder barrels."

Mr. Connor said further that the old adage that a rough cylinder wall surface is required to hold the oil film has been entirely exploded. He said that all American motor car manufacturers use the honing process as the final finishing process and that 66 per cent of the engines built in this country are mirror-finish honed in a secondary operation. His company has recently extended its line of honing machines for production lines to the service field because heretofore the average automobile owner has never been satisfied with an engine reconditioning job.

Discussing Mr. Connor's paper, C. B. Jahnke, research engineer, International Harvester Co., Chicago, said there is no question but that everybody is sold on mirror finish. He expressed the opinion, however, that corrosion is not a major cause of cylinder wear, saying that dirt in the air is the major cause and that air-cleaning is the remedy.

Neil A. Moore, assistant general manager, Sealed Power Corp., Muskegon, Mich., next presented a paper on "Piston Rings and Factors Contributing to Their Normal and Abnormal Wear", prepared in collaboration with J. H. Ballard and S. Nixon.

"In our experience with engine builders, as well as in the service field, coupled with a research into alloy materials conducted for us at the University of Michigan, we have not, up to the present time, found a material more universally suited for piston rings than a plain cast iron as we make it," Mr. Moore said. "Almost without exception we have traced problems of abnormal ring wear to details other than the metallurgy of the iron used in the piston rings. We are aware of one prominent manufacturer of Diesel engines who is using an alloy iron for piston rings with apparent success. This naturally is of great interest to us, and merits careful consideration."

Close cooperation between the engine designer and the ring manufacturer is desirable to develop a ring set-up which will insure satisfactory performance, Mr. Moore said. He admitted that the piston ring field demands a great deal of research, but the ring industry has neither the talent nor money to undertake it. He suggested that the Society set up a cooperative research program to discover the underlying reasons for piston and cylinder wear as well as to investigate the big problem as to piston ring materials.

In the discussion of this paper, Mr. Jahnke said his interest centers chiefly in the use of piston rings for high-speed Diesel engines. "The author speaks repeatedly of normal and abnormal conditions and wear," he said. "My experience leads me to the conclusion that to date under the most normal conditions obtainable piston ring wear is greatly abnormal. Evidently, then, there must be much room for improvement. . . . It is my opinion that piston ring engineers and makers need to find and apply a new line of thought on the subject of piston-ring application to the Diesel engine before we will approach practical and commercial rates of wear of either cylinder sleeves or piston rings. I apologize for such a harsh conclusion."

James C. Barnaby, consulting engineer, Worthington Pump & Machinery Corp., Buffalo, summed up his view of the situation thus: "You can't get good ring wear with improper combustion."

Wednesday afternoon's session was devoted to a symposium on air cleaners under the chairmanship of Mr. McCuen. The subject has become particularly important because the prevalence of heavy dust storms in many sections of the country, so violent that on at least one notable occasion New Yorkers were forced to breathe dust from the plains of Nebraska last Summer.

Fred R. Nohavec, chief engineer, Donaldson Co., Inc., St. Paul, Minn., presented the paper, titled "Air Conditioning as Applied to Internal Combustion Engines". He said, in part:

"All engine manufacturers are vitally interested in the service their engines give, and it is possible at this time to predict that in the near future every internal combustion engine, regardless of the field in which it works, will be factory-equipped with a good oil type air cleaner. Although the modern air cleaner is highly efficient and does not require as much attention as earlier models, it should, nevertheless, be given every advantage as to location and installation, as well as careful attention to servicing in the field. The life of the engine depends on the air cleaner's effectiveness more than any one other factor. Plans for the inclusion of the cleaner should be laid at the time the machine is taking shape. Designing the engine to incorporate the installation gives an opportunity of making more satisfactory connections by (1) having the distance from the cleaner to the carburetor, or manifold, as short as possible; (2) insuring tight joints, and (3) reduction in the cost of installation, and (4) allowing for correct size cleaner, which assures best results, which is not possible if the cleaner size is reduced on account of space.

"While the ideal cleaner will in all probability never be attained, exceptionally good results are being obtained with the modern oil-type cleaner. It is now possible to show an efficiency of 98½ to 99 per cent, while the operating time between servicings—even under extreme conditions—has been extended so that the care of the cleaner is no longer a burden. If the installation is incorporated with the engine design, the size of the cleaner and cost of the installation can be held at a minimum."

R. B. Gray, Bureau of Agricultural Engineering, U. S. Department of Agriculture, led off the discussion by saying the need of air conditioning cannot be emphasized too strongly. It has been applied to the theater, the railroad coach, the home, the office, and more recently the tractor, stepping up of the speed of which makes the use of cleaners more necessary than ever. Mr. Gray predicted that air conditioning soon will be necessary for the operator of the tractor, and already operators working under extremely dusty conditions cannot get along without a gas mask or some adaptation of its principle.

W. H. Worthington, research engineer, John Deere Tractor Co., Waterloo, Iowa, said there was need of a better measuring stick and suggested cooperation between engine builders and cleaner manufacturers to set up a standard and

sufficient means of determining requirements, evaluation of the problem, so that a true picture may be had. In other words, true scientific research must be applied if the problem is to be solved. He said in his experience, the laboratory setup falls far short of field conditions.

O. E. Eggen, research engineer, Oliver Farm Equipment Co., Charles City, Iowa, gave a resume of his company's test procedure worked out in its experimental laboratory with the idea in mind that it is his job to compare cleaners to determine that one cleaner is better or worse than another.

"When some of you who might wish to build a perfect air cleaner for engine manufacturers, keep this in mind: You can use up your entire store of experience gained and knowledge and imagination trying to make it foolproof, and, almost before the paint is dry on the first cleaner, some well-meaning innocent operator will pull a new one on you."

Numerous other speakers expressed the thought that the best solution of the air cleaner problem would be through the S.A.E. facilities, just as other major problems of the industry have been licked through adequate research programs.

A Diesel symposium occupied the Wednesday evening session, which was also a Chicago Section meeting, with a large attendance of local members. R. E. Wilkin, Standard Oil Co. (Ind.), was chairman. The welcome was extended by Harold Nutt, director of engineering, Borg & Beck Co., retiring chairman of the Chicago Section, while Mr. Warner responded on behalf of the Society.

Hans Fischer, research engineer, Buda Co., Harvey, Ill., presented the main paper, "The Combustion of High-Speed, High-Efficiency Diesel Engines", a revision of a paper he presented at the Summer meeting of the Society at Saranac Inn. Its essence was that the Diesel is approaching the internal combustion engine in smoothness and all other advantages, besides its high fuel economy.

Arthur J. Scaife, consulting field engineer, White Co., Cleveland, expressed the thought that not only has the Diesel a future, but it is enjoying it right now. He said the Pacific Coast is three or four years ahead of the Central West and East so far as Diesel-powered bus operation is concerned and pointed out that fuel economy has been an especially excellent development there.

A. W. Scarratt, chief automotive engineer, International Harvester Co. of America, Chicago, said that while much work remains to be done, the Diesel-engined motor-truck is on the way and must be reckoned with in transport work. He said 75 per cent of freight moved by truck in this country at present is by 1 and 1½-ton trucks, and he has not yet found any Diesel design that satisfies users in all respects. His company, he said, hesitates to sell the Diesel at present, pointing to the high cost penalty, high maintenance expense, lack of sufficient smoothness, presence of noise and smoke. However, he complimented engineers in the Diesel field for having made an excellent start and gone a long way toward a satisfactory truck power unit.

No paper presented at the meeting aroused more interest, nor such animated discussion as that entitled, "Design and Materials for Valves and Related Parts for Maximum Service" by Robert Jardine, chief engineer, Wilcox-Rich Corp., Detroit, at the valve session on Thursday morning. C. E. Frudden, chief engineer, tractor division, Allis-Chalmers Mfg Co., Milwaukee, was chairman.

Mr. Jardine said his paper was intended to call attention to some of the shortcomings of parts that are and have been in a continual state of change for many years—possibly more so than most other parts of an internal combustion engine. There never has been a time in the past 20 years when an engine designer could really say that the valves could be left without much attention. In spite of this, however, it has often seemed to him as if they received attention only after all other parts had been arranged to the designer's satisfaction, with the result that oftentimes the cost of operation and upkeep of the engine has been unnecessarily high. There are today notable exceptions that prove, however, that given proper attention the valve need not by any means be the weak member in the assembly of hard-worked parts—and that in spite of the load put upon it by the doubling of power output and speeds brought about by the demands of motor-car users and made possible by the excellent construction, lightening and balancing of most of the rotating parts, it was helped greatly by the fuels that are now available.

"It would be quite possible", Mr. Jardine declared, "if a motor were built up with every advantage taken of means for keeping valve mechanism performing properly, for a manufacturer to guarantee his valves for the average life of a car, in the first owner's hands, without much danger of its costing him much to make good his guarantee".

The paper said little of inlet valves in comparison with exhaust valves because they are pretty satisfactory as far as tight seating is concerned, but they are open to the same improvements as to spring locking devices as are exhaust valves, Mr. Jardine commented. After an exhaustive analysis of the subject, Mr. Jardine said:

"Were one to pick all the good points covered by this paper, taking somewhat for granted that they are good points, such an engine would have:

"Valves of high strength steel, probably austenitic and sodium cooled if necessary; possibly equipped with skirts to keep the gases from projecting oil vapor or particles of carbon onto the stem.

"Narrow faced Stellite rests on these valves.

"Stellite faced or other applied seat rings.

"Substantial clamping type spring retainer collars.

"Spherical rocking type washers under one or both ends of the springs, or some equivalent device.

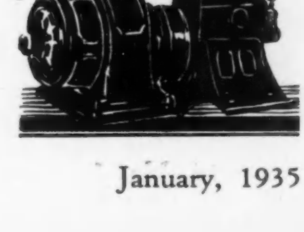
"Valve guides of non-growing material, probably Ni-resist; preferably not extending into the port.

"No-lash tappets of the hydraulic type.

"Cylinders with ports best suited to keeping valves cool. Exhaust manifold either far removed or cooled so as to avoid feed-back".

Were it not for the ease with which the detachable head type of construction can be cleaned and possibly because of the lower manufacturing cost, Mr. Jardine declared that one would almost say that an efficient engine should be of the one-piece construction. He pointed out that in the older types of engines in which the head was not separate from the cylinder, better valve performance had been had, adding:

"It is interesting to note that just recently in England the Lanchester car which is one of the oldest cars there, designed by an engineer whom we have always looked up to, has gone back to a one-piece cylinder and head construction. This Lanchester car is made now by the Daimler Company so that means this program has the support of the Daimler engineers also, who are among the oldest in the motor-car business".



Mr. Jardine also recommended valve rotation as some-

thing that should be again looked into. It has been tried many times and in those cases where it was done positively, it helped the valves but soon became noisy or was too complicated at the start, he said. Such simple expedients as two springs wound in the same direction, but the inner one of quicker pitch, and another consisting of a simple thrust washer of ball-bearing type under one end of the spring, are worth trying, he added. One old type rotating device effected a 15 per cent fuel economy. As to the ratchet type he said it probably will never come back because it was noisy and wearing.

At the conclusion of Mr. Jardine's presentation, Chairman Frudden exclaimed: "This is truly a masterful treatise, the best, I believe, I have ever heard at any Society session. It is so complete that hardly anything is left for discussion."

John S. Erskine, research engineer, International Harvester Co., Chicago, said the paper pushed into high relief the woeful lack of information heretofore available on the subject. "Why can't we have adequate literature on valve design and application of valves to installations such as we now have on bearings and their application. The engineering industry needs it badly."

A. T. Colwell, chief engineer, Thompson Products, Inc., Cleveland, congratulated Mr. Jardine, as did many other speakers in the discussion, and pointed out the great achievements of American aircraft engineers and valve designers as illustrated by the flights of Lindbergh, Post, Kingsford-Smith and the performance of the transport plane finishing second in the London to Melbourne race, all of which have contributed knowledge that should be made more generally available by a cooperative research program.

E. F. Smith, Chicago district manager, Haynes Stellite Co., Kokomo, Ind., asked cooperation of the engineers in a standardization program to bring the cost of seats on both seat rings and valves down to a more attractive level. Production of these is at present almost strictly a hand-work proposition because of the wide range of sizes and other specifications, small lot orders, and other factors. He said his company is trying to develop automatic machinery or at least make production more of a machine operation.

Low Temperature Operation

Elmer McCormick, chief engineer, John Deere Tractor Co., Waterloo, Iowa, opening the final session Thursday afternoon as chairman, called attention to the outstanding programs prepared and praised Chairman Krieger and the Committee in the highest terms, saying "These programs don't just happen!" He recalled that at the first meeting in Milwaukee, fuels and types of engines were the field covered, while at this meeting attention was given to solving the problem of engine wear. He said the biggest factor of engine wear is lubrication and that this final session was to be devoted to that subject. He then introduced A. J. Blackwood, chief research engineer, Standard Oil Development Co., who presented a paper entitled "Engine Performance at Low Operating Temperature".

"In every type of automotive operation, the performance of the engine at low temperatures is becoming increasingly important year by year," Mr. Blackwood said. "Improved highways with state and city facilities for keeping them open in even the worst winter weather have tremendously increased passenger-car, bus and truck operation in cold weather; air lines now operate the year around; tractors are rapidly replacing horses and a large part of their operation comes when temperatures are low; the railroads in all probability will greatly increase their automotive equipment and the problems of cold weather operation will interest them vitally. The marine engine, particularly in northern salt waterways, has always had its share of cold weather problems.

"There are in general four phases of engine operation which are of vital importance to the operator when low temperatures are encountered. They are (1) starting, (2) oil pumping (circulation), (3) sludging and (4) wear."

Exhausting each of these subjects, Mr. Blackwood gave these conclusions:

"To give the utmost satisfaction during operation at low temperatures, the following general rules might be suggested:

"1. Use a motor oil of proper viscosity at starting temperatures to insure easy starting.

"2. To minimize wear during starting, use the highest possible viscosity index. This will also insure optimum protection at high operating temperatures.

"3. Warm up as quickly as possible. This may be accelerated by thermostats, radiator shutters, rapid application of load, etc.

"4. Use only quality lubricants to minimize sludge formation.

"5. Maintain engines in good mechanical condition, particularly with respect to piston rings, valves and valve guides, and oil filters.

"6. For greatest protection, use only quality branded fuels.

"7. Engine builders might well give more thought to the possibilities of incorporating in design the use of non-corrosive steels; improvements in design to prevent blow-by past pistons and valves; incorporation of features to speed up the warming-up period; and provide means of maintaining high engine surface temperatures in cold weather."

Discussing the paper, Ralph C. Chesnutt, experimental engineer, Cleveland Tractor Co., Cleveland, said:

"Considering the greatly reduced cylinder wear when operating with water jacket temperatures above 140 deg. fahr. it might be concluded that even the most expensive thermostat or shutter control would be cheap compared with the repair costs involved when operating in cold weather without such heat control. On the basis of Mr. Blackwood's figures, it seems to me that the more costly type of by-pass thermostat should be more generally used. This type I believe shortens the warm-up period considerably by shunting the water around the radiator until the jacket water has reached the proper operating temperature. Radiator shutters and shutter controls seem to be losing favor, nevertheless the use of radiator shutters helps considerably in the control of the under-hood temperatures and carburetor and intake temperatures. This kind of temperature control should improve the warming-up period and should reduce cylinder wear. This kind of control also should reduce fuel consumption by permitting a nicer carburetor adjustment because of a more uniform under-hood temperature."

F. P. Hanson, Caterpillar Tractor Co., Peoria, Ill., said Mr. Blackwood's paper contained a great deal of valuable information for tractor manufacturers. While mechanical starting is gaining, the large percentage of tractors are still handcranked. Consideration must be given the fact that operators usually are content to make only one starting a day by hand, and that at the start of the day, because the starting job is hard work, especially in low temperatures, and it is easier to let the engine idle when not operating under load.

News of the Society

Regional Meeting Held in Hartford; Roos and Stout Speak on Program

PRESENT happenings in the automotive industry and a comprehensive outlook into future possibilities for the automobile, the motorbus, the railcar and the airplane—with tangible examples of new forms of these four vehicles already existent and in actual operation, as shown in motion pictures—were the main features of the Regional Meeting of the Society held in the ballroom of the Bond Hotel, Hartford, Conn., on Dec. 14.

About 275 members and guests were present at the technical session and 225 attended the dinner which preceded it. J. W. Beach, Mayor of Hartford, in a brief and appropriate speech, welcomed the diners to the City. The dinner was enlivened by instrumental music and the singing of familiar songs.

C. B. Whittelsey—a life member of the Society who joined it in 1910, was treasurer for 12 years and is now a member of its finance committee—was Toastmaster. He also pinch-hitted ably as Chairman in the absence of Robert Insley, sales engineer, Pratt & Whitney Aircraft Co., scheduled to preside. In presenting the guests of honor, Mr. Whittelsey was reminiscent of Connecticut's automotive pioneering work and its large contributions to development of the automotive and allied industries.

At the speakers' table were general manager John A. C. Warner, toastmaster C. B. Whittelsey, Mayor J. W. Beach, speakers D. G. Roos and W. B. Stout, and honorary guests Clayton R. Burt, president and general manager of the Pratt & Whitney Co.; B. H. Gilpin, vice-president and factory manager, Pratt & Whitney Aircraft Co.; John G. Lee, project engineer, Chance Vought Corp.; Hiram P. Maxim, consulting engineer; P. K. Rogers, president, Skinner Chuck Co.; R. B. Stoeckel, Yale University; and Curtis H. Veeder, inventor of the "Veeder" cyclometer or revolution counter.

Hiram Percy Maxim, famous inventor, in acknowledging his introduction to the audience, toyed entertainingly with speculations as to what might be expected from travel by rocket transportation and with ideas as to queer happenings that might occur if the force of gravity were eliminated.

The first speaker, John A. C. Warner, general manager of the Society, showed lantern slides of some of the automotive vehicles of the past as a background for presenting the high spots of the S.A.E. activities in connection with its 30th birthday anniversary year, 1935. He noted that of the twenty-three makes of cars in production in 1902, eighteen had engines to the rear of the center of the car.

Engineers were early in realizing the need for orderliness in the industry, he said, and hence originated the idea of, and the development of, automotive standards. Throughout the years progress in the automobile development has been paralleled by developments in S.A.E. activities in every branch of the industry.

Mr. Warner visioned the Society as a dynamic personality, a composite of what its members have unselfishly accomplished for the benefit of the public. He estimated the savings per year through the cooperation of everyone concerned in the industry at $10,000,000. As to how the Society has fared during the depression, he acknowledged that some members had been lost but said that the trend of the membership curve is now upward. Last year, 25,000 persons attended meetings of the Society and, in general, it has come through with colors flying. He noted that the Society has substantial reserves and, as an example of wise investment, that the securities held by the Society have never dropped more than 15 per cent from their purchase price. For the future, he sees the Society moving ahead steadily.

Roos Describes Present Progress

President D. G. Roos, in describing "What's Happening in the Automotive Industry", remarked that his was a "large order" because the fact that things happen so fast has a tendency to daze a person who tries to comprehend them. He noted a definite trend of the public

(Continued on page 18)

400 Attend No. Cal. Dance-Entertainment

● No. California

More than 400 people turned out for the annual "dinner-dance and holiday jinks" program of the No. California Section, held Dec. 14.

Maj. E. C. Wood, superintendent, transportation, San Francisco Division, Pacific Gas & Electric Co., and past-chairman of the Section, was in general charge of the arrangements. He was assisted by a committee representing Golden Gate B-10 Automotive Boosters Club, the Automotive Council of Northern California, the Service Managers Association and informal committees representing vocational divisions of the automotive industry in Northern California.

The program for the evening included a dinner and an ambitious entertainment schedule of 17 numbers. Music was furnished for dancing by Vern Vincent and his NBC Ambassadors. The party lasted from 7:30 until midnight. Not least among the attractions to the members was a printed program of 16 pages distributed as a souvenir to the members and guests who attended.

George H. Mosel, chairman of the Section, re-

A section of the speakers' table at the dinner held as part of the Hartford, Conn., Regional Meeting on Dec. 14. Those in the picture (l. to r.) are Curtis H. Veeder, inventor of the revolution-counter; John G. Lee, project engineer, Chance Vought Corp.; Hiram P. Maxim, consulting engineer; J. W. Beach, Mayor of Hartford; D. G. Roos, president of the Society; C. B. Whittelsey, vice-president, Hartford Chamber of Commerce, and chairman of the meeting; W. B. Stout, presidential nominee of the Society for 1935, and John A. C. Warner, secretary and general manager of the Society. Messrs. Roos and Stout gave the principal addresses of the meeting at a session which followed the dinner.

ports that "we have had a number of requests to duplicate this affair next year, which of course we will do, and endeavor to make it bigger and better, if possible".

Battery and Truck Meeting

Several papers were presented at the Northern California Section meeting held at San Francisco Dec. 4, the subjects covered being storage batteries and tires. A dinner preceded the technical session and 32 members and guests were present. The total attendance was 40.

Jack Frazier, of the Willard Storage Battery Co., presented Mr. Brunton's paper on storage batteries. The paper noted the changes in batteries and battery auxiliaries necessitated by recent demands of the aircraft and the automotive industries for batteries suitable for the operating of additional equipment, such as radio apparatus, and credit was accorded the Society for the assistance that S.A.E. Standards had given this development. Among the changes were those relating to charging rates, discharging rates, battery construction, and size and arrangement of plates. Methods of charging were discussed also.

Another paper was devoted to the "Retreading of Tires". It stated that during the last year some of the tire companies have installed retreading equipment, together with suitable retreading stock, and that, if the original casings are properly cared for, retreading practically doubles the life of a tire.

The subject of low-pressure tires was presented by a representative of the General Tire & Rubber Co., who also showed slow-motion pictures relating to them. A further feature was a paper entitled "Why Do Truck Tires Fail"? As a final feature, the story of the rubber tire was told by motion pictures.

Sampson Describes Valve Engineering

● So. California

Engineering features of valve design were presented at the Southern California Section meeting held Dec. 7 in Los Angeles. The dinner attendance was 46, and 56 were present at the technical session. P. J. Sampson, general manager for the Jadson Motor Products Co., presented the paper, its title being "Valves for Internal-Combustion Engines, and Their Related Parts". Alex L. Robb, vice-president and chief engineer of the same organization, answered the questions propounded during the discussion. E. E. Tattersfield was chairman.

Mr. Sampson presented a broad summary of the problem of valves for internal-combustion engines, and of that of their related parts. Considering the various types of valves, he said that the rotary is desirable in a certain sense but that the inherent inability to maintain fits makes it impractical. The sleeve valve of the single or double type is based on a reciprocating design and, as such, is impractical because of its relative excessive weight. The most commonly used type, the poppet valve, has almost as many disadvantages as it has advantages; but it is used on over 95 per cent of all four-cycle internal-combustion engines, the reason for its almost universal use being that, apparently, it is the best available design from all angles of the valve problem. It is light, and small, consequently presenting a low friction problem, and is the most positive type at high speeds and temperatures, particularly under the present-day high-output demands.

Regarding the difficulties presented by poppet valves, Mr. Sampson discussed excessive or elevated temperatures and their effects on inlet and on exhaust valves. He described what has been done toward the elimination of some of these difficulties. Advance in design has come almost entirely from the valve manufacturers themselves. As to valve seats, the latest development is what is known as a composite-construction inserted valve-seat. An outstanding example is the stellite-faced seats, which are extremely corrosion resisting but present quite a service problem because of the hardness of the face. In his opinion spring loads, as generally designed, are insufficient and should be increased 25 to 75 per cent. He then cited instances indicating very definitely that the valve problem in its entirety is one that can be worked out on a much more satisfactory basis than is true at present.

Current Problems in Aero Engines Covered in Outline by R. F. Gagg

● Metropolitan

NEARLY 350 members and guests of the Metropolitan Section heard four men in the aviation industry discuss several important aeronautic engineering matters at the monthly meeting of the section held Dec. 10. R. F. Gagg, experimental engineer, Wright Aeronautical Corp., presented the principal paper, dealing with current problems in airline engines in thorough-going fashion. He was preceded on the program by T. Park Hay, director of public relations, Transcontinental & Western Air, Inc., who gave an informal talk on flying overnight from coast to coast. F. W. Caldwell, chief engineer, Hamilton Standard Propeller Corp., gave a pertinent discussion of Mr. Gagg's paper, dealing especially with the effect of variable-pitch propellers on aircraft engine design. At a dinner, which preceded the meeting, C. S. (Casey) Jones spoke briefly on the training of pilots for blind flying. A. L. Beall, test engineer, Wright Aeronautical Corp., acted as chairman of the meeting and was introduced by Sid. G. Harris, Section Chairman.

Mr. Gagg gave a survey of the current problems which confront the designer of airline engines, pointing out many ways in which engines need improvement and the numerous problems which confront the engineer who seeks to bring these about. He dealt almost entirely with existing types, but admitted that there are possibilities of far-reaching changes in the basic type of design which may bring about a radical departure from existing practice. He said that engines of 950 to 1100 hp. are needed for certain airline work but are not yet in sight, at least in fully-developed form.

Mr. Caldwell made it plain that engine and propeller design are closely related and that the effects of vibration, among other factors, introduce difficult problems. He said also that we may expect that cabins will be supercharged as a means of adding to passenger comfort in flying at altitudes higher than are now feasible in transport work.

Rapid advances in transport flying from coast to coast were cited by Mr. Hay. Through the development of a new type of Douglas plane, which was considered almost impossible two years ago, and which was fostered by the company he represents, he showed how it has now become possible to fly from coast to coast with only three stops and without loss of time from business days. He said that comfort had been greatly increased and the feasibility of the service correspondingly enhanced by the excellent job of noise insulation work accomplished by Stephen J. Zand of the Sperry Gyroscope Co.

In discussing Mr. Hay's remarks, Mr. Zand said that the insulation had been effected by the use of only 166 lb. of material, about 100 lb. of which would have been needed in any case for interior decoration. This was possible, however, only by the closest cooperation with the designers of the plane, starting when the initial design was laid down.

In other discussion, in which F. C. Mock, C. M. Larson and H. A. Franchimont, took a prominent part, it was brought out that, especially for long-distance flying, high fuel economy results in greater weight saving and higher useful load than is likely to be realized in efforts toward extreme lightness in engine construction.

Almen and Pierce Tell How Power Losses Occur

● Buffalo

J. O. Almen and Earl Pierce, of the General Motors Research Laboratories, presented a joint paper on "Gas-Tank Leaks" at the Nov. 20 meeting of the Buffalo Section, which was attended by 95 members and guests.

Messrs. Almen and Pierce began their presentation by showing on slides the available energy in gasoline. Taking as typical a 100 hp. engine they then showed curves giving the percentage of power output used in useful work, lost in engine friction and pumping. The effects of cooling water, exhaust and muffler radiation, transmission, rear axle, tires and windage were also shown graphically.

Mr. Almen stated that due to the higher speeds, oil consumption necessitated higher piston-ring pressures resulting in increased engine friction in modern cars. This condition is being offset somewhat, in his opinion, by the use of lighter oils while the higher octane fuels reduce the engine-heat rejection to the cooling water.

Mr. Pierce discussed at length the rather serious increase in horsepower consumed by tires as the sizes become larger each year and tire pressures become less.

Slides shown during the presentation gave the past and future trend in car weights for a given price class, past history of factors affecting fuel consumption and possible trends for the future.

Dinner-Dance Has Speaker on India

● Oregon

The annual dinner-dance meeting of the Oregon Section was held Nov. 9 at Lloyd's Golf Club, Portland. The speaker of the evening was John B. Delaunay, C.S.C., Ph.D., Dean of Men, Columbia University. Dr. Delaunay's topic was "Transportation and Other Problems in India", based on extensive residence and travel in that country. Ladies were invited to the meeting and refreshments and entertainment were provided. The total attendance was 54.

Horine Gives Truck Paper

● Baltimore

Merrill C. Horine, sales promotion manager, International Motor Co., New York, spoke on "Motor-Truck Development and Future Possibilities", at the Dec. 5 meeting of the Baltimore Section. The meeting was attended by 29 members and guests with 15 at the dinner preceding it.

Stamping and Die Problems Bring Record Crowd for Three Speakers

• Detroit

STAMPING and welding—the twin topics of probably greatest automotive production interest today resulted in bringing out to the Dec. 3 meeting of the Detroit Section a near record if not a record attendance for any meeting of the Section at this time of year.

Sponsored jointly by the Production activity and the Body activity of the Section, the three papers by Jerry Bingham, Toledo Stamping and Mfg. Co., Guy Hartsock, master mechanic, Hudson Motor Car Co., and Malcolm Clark, chief engineer, Taylor Winfield Corp., virtually formed a symposium on modern automotive sheet-metal working.

Mr. Bingham, whose topic was "Some Fundamentals of Dies and Stampings", as a matter of fact went beyond the automotive field to bring the history of stamping fundamentals up to date. In these fundamentals, Mr. Bingham said, there has been little change since the early days of stamping history. The big difference has come in the application of the fundamentals.

It was Mr. Bingham's contention that even a thorough grounding in the fundamentals of die construction is not a criterion in itself for the production of successful dies and stampings. Addressing automotive engineers in general, Mr. Bingham went even further, saying "A lot of you don't know what you want even if you think you do".

To illustrate his contention that there is a tendency among engineers toward unwillingness to accept as possible that which they did not themselves conceive as possible, Mr. Bingham recalled that his company, Bingham Stamping Co., at one time produced some 5,000,000 brake levers for one of the two largest manufacturers by stamping before the second of the two largest could be convinced that stamping would actually reduce the cost.

Among the most important fundamentals of die construction and stamping, Mr. Bingham reiterated the requirement that "Dies should never come in contact with each other". If they do, he said, misalignment is caused producing burring, etc. It is the recognition of the importance of this factor, he said, which caused the introduction of sub-presses to increase productivity per set of dies to increase from 300,000 to millions of pieces.

His suggestion as the best way to prevent die-interference in the press was to place tissue paper between the punches, dies, etc., before casting on the head.

Following Mr. Bingham's paper, Mr. Hartsock took up the problem of large dies and stampings discussing some of the problems encountered by the Hudson Motor Car Co. and the ways in which they were solved, using blackboard sketches to illustrate his points.

An interesting comment of Mr. Hartsock's was that about 10 years ago Hudson purchased considerable press equipment and at that time selected such equipment from 50 to 100 per cent oversize, believing that safety factor for size of stampings would be ample for some time to come. Since then, Mr. Hartsock said, it has been necessary to increase the size and capacity of this equipment. In the last four years, he said, at least 75 per cent of the equipment has been enlarged. A few years ago the largest dies weighed in the neighborhood of 18 tons. Today, he pointed out, dies weighing 90 tons are not out of the way.

Mr. Hartsock emphasized the necessity in die design to provide for locating the metal so that as much as possible of the operation on deep section stampings could be made by "forming" in the press, thereby reducing the amount of draw finally required. At the present time as a matter of fact, he pointed out, fenders were being produced with a draw requiring an elongation of as much as 40 per cent.

Following these two papers, V. P. Rumely, assistant vice-chairman of the Section for the Production activity turned the meeting over to W. J. Waterbury, vice-chairman of the Body activity, who introduced Mr. Clark and his paper "Why Use Welding?"

Mr. Clark's own answer to his topical question was another question: "What could we use to replace welding?" In his paper in addition to discussing numerous problems in which welding enters, and which are associated with modern production welding, Mr. Clark asked for more and earlier cooperation between design divisions and welding engineers. Pointing out the rapid strides in the arts of welding, particularly resistance welding, and the fact that welds are performed today which would have been considered absolutely impossible a few years ago, Mr. Clark emphasized the necessity for design engineers to get in touch with welding specialists before the design is too far advanced.

"The trouble is that after the design has been released and dies made", Mr. Clark said in offering an example, "everyone is very reluctant to authorize an engineering change—so they attempt to get by with the part as it is and welding operation is unsatisfactory. This often leaves the impression with management", he continued, "that welding is not so good, whereas, if the parts had been properly engineered, there would have been no question about the success of the welding".

There is no limit to the size of piece which can be satisfactorily welded, according to Mr. Clark, and practically no limit to the combination of materials which can be welded together if desired. As a satisfactory weld he defined one in which the strength of the weld is the same as that of the pieces joined, and one which requires no solder or filling. Such results can be achieved however, he said, only by designing parts for welding.

Among the important welding considerations he mentioned the following:

Transformer capacity should be ample to avoid necessity of raising voltages (producing hard welds, pin holes, etc.) Safe rule—150 KVA per sq. in. of cross-sectional area at the weld, with 18 to 20 gauge stock.

Clamping pressure must be ample to eliminate any slippage of stock in welding dies when final push-up is made. Good rule—800 lb. per in. of die length for body stock welding.

Machine rigidity—particularly important with light gauge stock, since deflection of die on one side of .025 in. would permit only very small proportion of .037 in. stock to be actually welded. Insufficient rigidity major cause for requiring much use of solder.

In emphasizing the need for cooperation between design engineers and welding engineers, Mr. Clark named some of the considerations required for successful welding which would be incorporated in the design probably only as the result of specialized consideration to welding as a production means. Among these were:

Two metals of same resistance to be welded should be close to same sectional area at the weld for uniform welding temperature. Variations permissible where electrical resistances of pieces to be welded differ.

Must provide for location for clamping jaws or current carrying dies, particularly in welding forgings to bars or stampings. This controls shape of forging to some extent. Must be able to apply heat locally near the weld point.

In flash welding light-gauge metal it is important that outside surfaces should be kept next to the stationary die to produce perfect alignment outside the body, on account of thickness variations in stock.

In answer to a question Mr. Clark said that welding is quite feasible and satisfactory with some of the "light metals", but that with some of the aluminum alloys considerable difficulty is still experienced in producing a thoroughly satisfactory weld.

Annual Meeting Exhibits

AN engineering exhibit for engineers, in charge of engineers, will be held Jan. 14 to 18 in the Book-Cadillac Hotel, Detroit, as one of the features of the S.A.E. Annual Meeting. The list of exhibitors appears below, in alphabetical order. Visit the exhibits when you attend the Annual Meeting.

Aluminum Co. of America
American Cable Co.
Bantam Ball Bearing Co.
Barber Colman Co.
Bussman Manufacturing Co.
Campbell, Wyant and Cannon Foundry Co.
Cleveland Graphite Bronze Co.
Continental-Diamond Fibre Co.
Detroit Edison Co.
Doehler Die Casting Co.
The Dole Valve Co.
Ford Motor Co.
The Globe Machine & Stamping Co.
Harrison Radiator Co.
Hercules Motors Corp.
Hutto Engineering Co.
Inland Manufacturing Co.
The International Nickel Co., Inc.
Micromatic Hone Corp.
Monroe Auto Equipment Co.
Parker-Kalon Co.
Pratt & Whitney Co.
Ray Day Piston Corp.
The Skinner Chuck Co.
Spicer Manufacturing Corp.
Tinius Olsen Testing Machine Co.
Turnsignal Corp.
United American Bosch Corp.
Victor Manufacturing & Gasket Co.
Waukesha Motor Co.
S. S. White Dental Mfg. Co.

All-Aviation Program Staged by N.W. Section

• Northwest

"Aircraft Instruments and Their Uses", a paper by Louis Wait, test pilot, Boeing Aircraft Co., and "The Measurement of Landing Speed and Other Test-Flight Procedure", a paper by Ralph L. Cram, research engineer of the same company, together with an impromptu talk on aviation's latest developments and status by G. W. Carr, the company's vice-president, featured the annual aviation meeting of the Northwest Section, held Dec. 14 at the New Washington Hotel, in Seattle. About fifty were present. John G. Holmstrom, section chairman, presided. Mimeographed copies of the two papers were handed to everyone in attendance, this feature being used for the second time, and seemed to meet with approval.

Mr. Wait first explained the engine instruments, most essential of which is the tachometer, he stated. Other engine instruments on the modern plane: oil pressure, manifold pressure and oil temperature gages. Navigation instruments were then considered, the altimeter being the primary one. Others: the compass, airspeed indicator, a sensitive pressure gage, actuated by the air pressure on a pitot head set up by the airplane's forward motion; the turn and bank indicator, a gyroscopic instrument which indicates change in direction of plane; a steel ball in a level tube in combination with the gyroscope to indicate the plane's lateral axis or wing level; a climb indicator, which serves as a statoscope, and the directional gyro and artificial horizon, discussed in connection with the Sperry automatic pilot. All these instruments are essential in "blind flying" and, Mr. Wait said, "enable the pilot to fly the airplane correctly during all conditions of visibility."

Continuing he said; "We now have a complete system of airplane control which can maintain the plane on any desired course, maintain a constant altitude and keep the wings quite level. The reaction of the automatic pilot is quite rapid, requiring only about one degree change of altitude to set up a corrective control motion."

Mr. Cram's paper explained the method of measuring flying speeds, but gave most attention to landing speed computation. The method used by the Boeing Aircraft Co. is considered the most accurate and may be officially adopted by the Department of Commerce as standard, he stated. Equipment consists of a 35-millimeter moving picture camera, a large grid and an anemometer. As the landing airplane comes within the range of the camera and the grid, a series of pictures are made. The grid is placed 10 ft. in front of the camera lens, and out on the runway, 400 ft. in front of the lens, strips of cloth are laid on the field to indicate to the pilot where the airplane must land. At the time of each landing the wind speed is measured with the anemometer and the spot on the landing field strip that the wheels touch the ground is jotted down in a note book. The wires on the grid are spaced 6 in. apart. Each wire on the grid represents 20 ft. on the landing strip. Twenty or 30 exposures are made while the plane is crossing the full width of the grid, and knowing the number of exposures per second, and the distance of travel each grid square shows, it is a simple matter to calculate the ground speed of the airplane just as the wheels touch the runway.

Another Boeing development which Mr. Cram explained was the method of testing streamlined shapes in actual flight. This consists of putting lines of lamp black mixed with oil on parts of a new plane where air flow is to be studied. After the plane has been in flight a short time the oil-air picture is written thereon, as the mixture flows out in the lines that the air is taking.

Vice-President Carr's remarks stressed the importance of adopting a standard for measurement of landing speeds, such as the Boeing grid method. Price increase of airplanes was lucidly explained with the outstanding reasons given as better construction of today, such as trussed structure with metal skin; difficulty of forming aluminum alloy compared to steel, and the higher costs of materials used, while tooling costs had also greatly increased. Engineering costs are also higher than formerly, as more parts must be carefully designed than in older models.

In building aircraft for military uses, Mr. Carr said, performance was the major factor; for commercial use, in addition to performance per se, pay loads were an important consideration. He urged that the aircraft industry be kept strong, as a national defense, pointing out the need for quantity production capacities of the American plants. Air-cooled engines, he said, in answer to a question, compared very favorably with water-cooled, as to drag. He predicted that the Diesel engine would be revived again for aircraft use.

Shoemaker & Probst Give Spring Paper

• Philadelphia

The material on "Independent Springing with Leaf Springs" given previously at meetings of the Pittsburgh and Cleveland Sections was presented Nov. 14 to the Philadelphia Section by John H. Shoemaker, commissioner, Leaf Spring Institute, and Karl K. Probst, consulting engineer, Leaf Spring Institute.

An additional feature of the meeting was presentation of data on the "Porsche Torsion-Bar Suspension" by P. M. Heldt, engineering editor, *Automotive Industries*.

The meeting which was held in the rooms of the Philadelphia Automobile Trades Association was attended by 175. The dinner preceding the meeting was attended by 91 and discussion of the topics was offered by John Warren Watson, president, John Warren Watson Co., and Mr. Schaff of the Schaff Spring Service.

Two Teetors Tell of Piston Rings

• Cleveland

Ralph R. Teetor, in charge of engineering department, and Macy O. Teetor, factory manager, Perfect Circle Co., presented a joint paper on "The Relation of Piston Rings and Cylinders to Engine Performance" at the Dec. 10 meeting of the Cleveland Section. The meeting was held at the Cleveland Club and was attended by 160 members and guests. Dinner preceding the meeting was attended by 64.

A. T. Colwell, chief engineer, Thompson Products Inc., was sponsor and chairman.

Presents Program For Air Commerce

• Philadelphia

John H. Geisse, chief of development section, Bureau of Air Commerce, Washington, was scheduled to speak at a Philadelphia Section meeting on Dec. 19 on "The Development Program of the Bureau of Air Commerce".

The Aircrafters, a Philadelphia organization of men in the aeronautic industry, were to participate in the meeting. W. Laurence LePage was to be chairman of the meeting.

"Army Night" Program Dwells on Motorization

• Washington

Col. Benjamin F. Miller (F.A.), Q.M.C., and Major Harold A. Nisley, Ordnance Department, were guest speakers at the "Army Night" meeting of the Washington Section held on Dec. 10, following a dinner at the University Club.

Colonel Miller spoke on "Modern Military Motorization", or the adaptation of commercial types of vehicles for the transportation of army supplies, ammunition, etc. Tactical doctrines of the Army require that a vehicle possess cross-country ability nearly equal to that of the horse or mule; hence, traction is essential, and numerous caterpillar and multi-wheel drive vehicles have been developed in order to attain it. Some of these vehicles are convertible and travel on wheels at high speed on good roads, the tracks being applied to the wheels when bad ground is encountered.

Major Nisley spoke on "Modern Military Mechanization", or the development of vehicles suitable for combat purposes, such as tanks and combat cars, armored cars, scout cars, half-track vehicles and tractors. Tanks are used as accessories in infantry assaults, while combat cars and armored cars are employed by the cavalry for use in assault and reconnaissance missions, respectively. The value of such vehicles lies in their protection, fire-power and mobility. As mobility is of great importance, such vehicles must be able to attain high speeds on good roads, and Major Nisley traced the development of many convertible wheel-and-track and half-track vehicles meeting this requirement.

Some excellent slides were shown during the lectures, and an interesting movie of the various vehicles being put through their paces brought the meeting to a close. Forty members and guests attended.

Holds Joint Meeting On Bearings & Metals

• Dayton

A joint meeting with the Dayton Chapter of the American Society for Metals was held Dec. 11 by the Dayton Section. C. H. Bierbaum, vice-president and consulting engineer, Lumen Bearing Co., Buffalo, N. Y., talked on "Bearing Metals Brought Up-to-date". In his discussion largely based on personal experience, he covered leaded bronzes or emulsions, nitrided and chrome-plated journals, the corrosion effects of oxidized lubricants and factors limiting bearing life, etc.

R. R. Kennedy, metallurgist, Wright Field, U.S. Army Air Corps, presented a series of slides on non-ferrous materials explaining their characteristics and structural features.

Winter Maintenance Problems Discussed

• New England

Maintenance subjects especially applicable to winter operations were discussed at the Nov. 13 meeting of the New England Section. J. R. Hill, Standard Oil Co. of New Jersey, described "New Developments in Winter Motor Oils" and H. H. Hopkins, National Carbon Co., "Cooling-System Service and Anti-Freeze Materials".

A projected paper on "Precision Motor Tune-Up" by W. S. Marsden, Ethyl Gasoline Corp., was postponed because of the speaker's absence in Detroit.

The meeting held at Walker Memorial, Massachusetts Institute of Technology, was attended by 108, with 58 at the dinner preceding.

Creson Gives Talk At Safety Meeting

● Indiana

At the safety meeting of the Indiana Section held Dec. 13 at Lafayette, Ind., the total attendance was 75. The members and guests visited the Ross Gear & Tool Co's. plant in the afternoon, and 60 attended the dinner which preceded the formal evening meeting.

Three papers were presented. W. K. Creson, chief engineer of the Ross Gear & Tool Co., chose as his subject "Steering Safely", and dealt with the functional safety and the physical safety of steering units. The paper by A. W. Feragen, field supervisor for the Bendix Products Corp., was entitled "Performance Standards for Motor-Vehicle Safety-Inspection". The third paper was on "Coordinating Highway and Automotive Developments", the author being John W. Wheeler of the Indiana Highway Commission. Prominent in the discussion were: H. M. Jacklin, Herman Winkler, Charles Merz and Louis Schwitzer, Jr.

The subjects covered in Mr. Creson's paper included the mounting number of motor-vehicle accidents, the responsibility of the automotive industry in curbing them, and the classifying of steering units as to chassis front-ends, steering gears and connecting linkage. The contributing factors of a safe steering job were stated as being the inherent stability of the vehicle, friction-free linkage, low steering-effort and road sense or steering by touch.

As to making the product safe, Mr. Creson discussed this with reference to a conservative policy with respect to changes, the selection of materials, metallurgical control in production, training of personnel, reduction of labor turnover, and thorough inspection routine. Servicing for safety includes the lubrication of units and inspection after accidents. The ideal safety combination was stated to be a safe vehicle properly serviced, safe highways and safe driving habits.

Mr. Wheeler made the point that the highway engineers and the automotive development men should get together and at least know what the others are going to do. As it is, the highway engineers for many years have built their roads to accommodate the current type of cars, only to find their best-designed road obsoleted in a few years by speed and other motor-car developments of which they knew nothing when designing the roads. He does not believe in "getting laws to govern the cars and the drivers". He does believe that, if leaders in the two fields got together frequently, they might be mutually helpful to each other. In answering the question as to why the roads were not better banked or super-elevated he said that in newer roads that is being done as rapidly as possible but that there are limits. If a curve is banked for 80 or 90 m.p.h., for instance, cars at low speed, especially in slippery weather, will slide off the road. The Indiana Highway Department is rebuilding older roads to new high-speed standards.

Colorado Group Starts Season

● Denver

The S.A.E. Club of Colorado held its first meeting of the season on Nov. 13 in Denver. The meeting was held at the plant of the Eberhardt-Denver Co. Mr. Eberhardt talked to the 30 or more members who attended on the practical aspects of gear cutting and displayed a Diesel engine constructed in the shops.

Dean M. Gillespie was elected president of the club for the ensuing year and Thomas Thompson was elected secretary and treasurer.

Research Foundation Work is Described

● Canadian

The work carried out by the Ontario Research Foundation since its inception in 1927 was described at the Nov. 21 meeting of the Canadian Section by Dr. R. H. Speakman, director of the Foundation.

Particular reference was made to projects carried out for the automobile industry. The Foundation has done considerable work with automobile fabrics in relation to their wear and fadability. In carrying out many of the tests on fabrics it was necessary for the Ontario Research Foundation to develop its own testing apparatus, none being available at the time. Definite standards on pile, wear and color were established as a result of the fabric tests.

The meeting was attended by 60 members and guests.

New Oil Developments Described by Wilson

● South Bend Regional

At the Regional Meeting of the Society held in South Bend, Ind., Nov. 7 and previously reported in the December issue of the JOURNAL, Dr. R. E. Wilson, vice-president in charge of research and development, Standard Oil Co. (Indiana), spoke on "Recent Developments in the Manufacture of Motor Oils". D. G. Roos, president of the Society and chief engineer, Studebaker Corp., was chairman of the meeting. Attendance was approximately 225, twenty-five of whom came from Chicago —the Chicago Section acting as sponsors for the meeting.

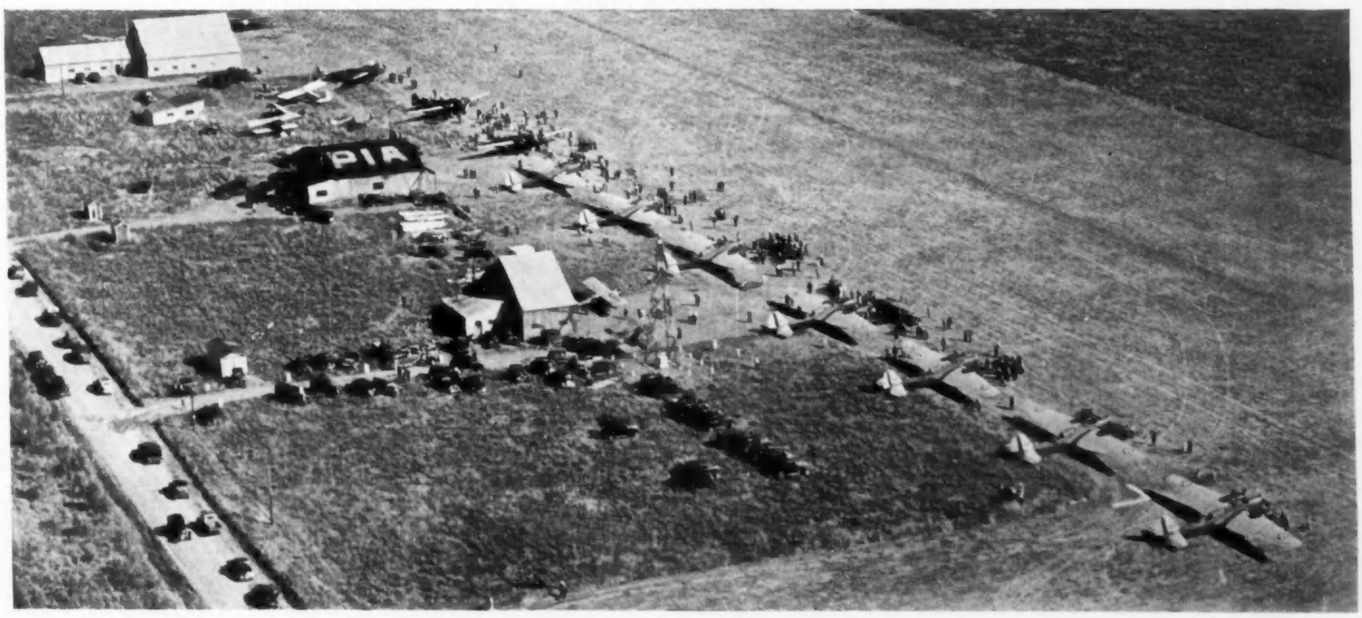
Dr. Wilson discussed in some detail the properties of motor oils which indicate quality, the principal ones being:

1. Viscosity temperature characteristics
2. Pour test
3. Tendency to form engine carbon
4. Stability—resistance to oxidation.

He discussed the motor oils manufactured in a conventional manner from various types of crudes, pointing out that motor oils made from certain crudes excelled in certain quality characteristics but were inferior in other quality characteristics, and that it depended upon the type of crude used in so far as the quality characteristics in which motor oils excelled were concerned.

Dr. Wilson pointed out that in the last two or three years a great amount of research work had been conducted to develop a refining procedure to manufacture motor oils which excelled in all of the essential quality characteristics. He also indicated that the industry had spent or appropriated, during the depression, $15,000,000 (approximately) for new equipment for the manufacture of such motor oils.

Dr. Wilson outlined the various steps in the development of propane dewaxing, explaining



● Detroit

This is Alaska! Planes of the Army Alaskan flight are shown grounded at Anchorage, Alaska. Details of the flight and servicing of the planes were described by Major Ralph Royce at the Nov. 5 meeting of the Detroit Section

that it had been found (contrary to expectation) that the solubility of paraffine wax in liquid propane was very low, and that in liquid propane solution the wax was crystallized out in such form that the solution could be readily filtered.

Propane has another decided advantage in that the temperature of the solution for precipitating the wax can be reduced by self-refrigeration which occurs when part of the propane is allowed to evaporate. This means of refrigeration is much more convenient and less costly than securing refrigeration by lowering the temperature with outside refrigeration, as has been done in the past. Dr. Wilson also presented pictures and flow charts of propane dewaxing plants which are in operation at the present time.

It was explained that many attempts had been made to improve the viscosity temperature characteristics of motor oils and that solvent extraction had been tried with practically every known organic liquid. It has been ascertained that many organic liquids will separate the naphthenic type of hydrocarbon from the paraffine type.

When the paraffinicity of the oil is increased by one of these methods, the viscosity index is correspondingly improved so that motor oils can be made from practically all types of crudes which have viscosity indexes similar to those normally manufactured from paraffine base crudes. It was pointed out, however, that it is not economical to make such oils from all crudes, although these methods greatly increase the quantities of the lubricating stocks available for the manufacture of high grade motor oils. The improvement obtained by increasing the viscosity index of motor oil also improves the oil from the standpoint of oxidation stability. Dr. Wilson showed pictures of flow diagrams and commercial plants now used for manufacturing motor oils with solvent extraction, using dichlorethylene as the solvent.

Dr. Wilson pointed out that the tendency for motor oil to form carbon in an engine was not dependent upon its carbon residue, but instead, upon the volatility of the last 10 per cent of motor oil. He explained that this can be controlled in some cases by making motor oils from completely distilled stocks, and in other cases, by making a propane extraction of bright stock. When the propane extraction method was used, it was found that the asphaltic type of material was not soluble in the propane solution under properly controlled conditions.

There was considerable discussion following the paper in which Mr. Roos, Mr. Sparrow of the Studebaker Corp., Lee Oldfield, Indianapolis, B. J. Lemon of the U. S. Rubber Co. and others participated.

Hartford Regional Meeting

(Continued from page 13)

to use smaller and less costly cars, and said that 95 per cent of those in use cost less than $1,000. The main advantage of the large car with a long wheelbase was its ability to carry seven passengers. The public has found the small car better than it was at first thought to be, since it has a better performance than does the large car. Further, new methods of suspension and other improved features enable it to challenge the big car. This has been brought about by the fact that were the production to be, say, 300,000, more money is available for research than would be true for smaller production. Of the factors responsible, one marvelous improvement is the increase in horsepower with a smaller engine. He thinks streamlining is not an important factor, and that the public likes it "because of its looks". He regards streamlining as a school of design, and said that at 75 m.p.h. only about a 15 per cent gain is accomplished.

Taking a 1928 eight-cylinder-in-line 250-cu.-in.-displacement engine as an example, Mr. Roos cited the increase from 91 hp. at 3600 r.p.m. to 146 hp. at 4000 r.p.m. as exemplified in a 1933 racing-car engine of similar type. This was accomplished by the use of higher compression, the use of No. 70 octane fuel, improved combustion-chamber design, use of aluminum heads, ability to time the spark more accurately, and the like. The ideal would be to time the spark so that it would vary with the speed and to run the engine at say 4500 r.p.m. Other features are improvements in manifold and carburetor design, such as the use of the duplex carburetor to minimize the ramming effect in the manifold and installing carburetors in tandem.

Further practicalities are the ability to use colder mixtures because of better heat control on the manifold and hence, with the colder mixture, the ability to use carburetors of extremely low resistance. The subject of colder mixtures should be studied, Mr. Roos said. He believes that good results can be gotten without supercharging. Blowby, he stated, occurs when the inertia stresses balance the explosion pressures. It is "simple, like all great things", he remarked, and then described how blowby can be cured by making various changes in the piston-ring design and stopping the tumbling of the pistons.

As to connecting-rod big-ends, many have been lost at high speed because "all is not as it looks on the drafting board", Mr. Roos said. One remedy has been to raise the oil pressure and lengthen the oil groove. Much work has been done on valve-spring problems as to the prevention of valve-spring surge and the like. Since the P-V values at high speeds are very high, the tendency is to use larger crankshafts with bearings between each crank throw. He stated that some high-speed engines running at 4500 r.p.m. are safer and better than engines that ran at 3200 r.p.m. five years ago. He touched upon clutch improvements such as the fluid flywheel, but remarked that some of these clutch problems have not as yet had a commercial solution. The mercury clutch is smooth in action but, he said, it cannot be locked and made into a conventional clutch.

Mr. Roos noted two types of overdrive; (a) a planetary gear on the rear axle and manual operation, and (b) the planetary type with helical gears. He stated that "the automatic type is the type to use". In one form of overdrive there is no acceleration and it is necessary to shift to ordinary gear to pass another car. The public will not do this, he said. He thinks the automatic type will be used in the coming year, and said that it was delightful to drive with it. As to automatic transmissions, they must function both on speed and torque, in his opinion. The difficulty lies in their cost and weight. There is no gearbox that is satisfactory as yet, and it would cost say two or three times the cost of an ordinary gearbox. He does not see that an automatic gearbox will be in use for some time to come.

As to independent wheel suspension, Mr. Roos noted that this necessitates compromises in car design. The factors are the quality of the ride, roadability and stability. If one of these factors is modified, the designer gets into trouble with the other two factors. He mentioned the stabilator—which is a bar across the car, generally at the rear—and described different types of wheel suspension and devices used to overcome the defects in each.

Stout Looks to Future

William B. Stout, in a prophetic and practical presentation of "The Possibilities of the Automobile", which was accompanied by lantern slides and motion pictures, first noted the world's respect for the automotive achievements of Hartford and the development of aviation which had originated in that city. He remarked how envious foreign nations are of the achievements in powerplant originating here. The powerplant is the basic thing. The automobile engine was the beginning and the aircraft-engine trend then took its own direction of development. But the aircraft industry has now turned back to the automotive industry more than it ever took away from it; such as the development of aluminum heads and the possibility that an automobile engine might be cooled with air and might be made to weigh as little as 3 or 4 lb. per hp. Wonderful improvements to automobile engines have been accomplished by using aviation experience. He also discussed what the airplane itself can pass on to the automotive industry.

Passing to economics, Mr. Stout remarked that the automobile developed a new set of conditions for living. In the age of the horse, the social radius was 15 miles. In each generation perhaps one new thing was developed and one only, and conditions did not change. Then began *research* and engineers were governed by facts and not by mere opinions.

Discussing the creation of wealth, Mr. Stout remarked that nobody knows what money is. Wealth comes only from luxuries and wealth is measured by the living conditions of the average man. High wages and short working hours are necessary under present conditions. He stated that the automobile industry created the automobiles and also the money to buy them. More people than formerly want things today. The demand is for building up of new industries that are all ready to start. In Mr. Stout's opinion, the railroads are doing a sincere job in trying to come out of the doldrums. It is hard to change former practices and to get away from well established assumptions; for example, an automobile engineer could not design a watch. The biggest thing is the development of economics. The railroads have been hampered by financial aspects of their problems and cannot change rapidly from old practice, such as the lessening of vehicle weight and the like.

Mr. Stout said that now the world moves so fast that everything useful in it must be replaced frequently. He then noted that replacing a car each year would mean that the production of cars would be increased three or four times. He advocated building houses on an automotive basis. For instance, everything in an existent house today is obsolete, and he suggested that houses be *manufactured* and fitted with air-conditioning equipment and all the other devices of the most modern type.

Mr. Stout has applied airplane-engineering experience to the development in his laboratory of the railcar, the motorbus and the automobile. He has applied the fuselage and wing-construction principles of the airplane to the body construction of these three. The motorbus carries 24 passengers, and has a top speed of 75 m.p.h.

Lantern slides and motion pictures were shown by Mr. Stout, these being inclusive of various types of airplanes, of his "railplane" or new-type railcar which is rubber-insulated and has practically no vibration, of his rear-engined motorbus and of his new-type rear-engined automobile. He said that any vehicle that runs on land cannot be streamlined because of varying winds, and that the main advantage of streamlining below a speed of 60 m.p.h. is in regard to ease of steering. The automobile shown has, as some of its unique features, great smoothness of operation, roominess in that its full width is utilized because it has no running boards, great acceleration ability, and practical absence of vibration.

Papers from Recent Meetings in Digest

HERE are digests of papers presented at recent Section or Regional Meetings of the Society, and at the National Tractor and Industrial Power Equipment Meeting, held in Chicago, Dec. 5-6, 1934.

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Some of these papers will be printed in full in the S.A.E. JOURNAL.

Mimeographed copies of *all of them* will be available, until current supplies are exhausted, at a cost of 25 cents per copy to members; and at 50 cents per copy to non-members. Orders for mimeographed copies must be accompanied by remittance and should be addressed to Sessions Secretary, Society of Automotive Engineers, 29 West 39th St., New York.

Pittsburgh Section Paper

Tuesday, October 2

Development of a Transverse Leaf-Spring Independent Wheel Suspension System—*Karl K. Probst, Engineering Division, Leaf Spring Institute.*

FIRST consideration was given to the front system. The problem was that of the selection of the design which, at the lowest cost and weight, would offer possibilities of equal or better performance than in cars already in the user's hands.

The two main types of transverse independent leaf-spring systems—the equal and the unequal-parallelogram types—are commented upon at length, and details of the design adopted are given.

In the rear mounting the differential unit was placed in the frame, on rubber mountings, to eliminate noise and gear vibration, and the springs were mounted on the bottom of the differential casing. Two short driveshafts transfer the power to the full-floating wheels, with the balance of the construction practically the same as the front.

The preliminary check-up indicates very little increase in weight and cost in this type of independent front suspension over a conventional design. In the rear, there is a slight additional weight and cost. It is believed that the entire combination—front, rear and frame—can, after more study, be brought to approximate the costs of present designs, and with a saving of 60 to 80 lb. in the weight of the complete chassis. About 40 lb. of unsprung weight is saved in the front and 100 lb. in the rear, as applied to a 3000-lb. standard-sedan.

Baltimore Section Paper

Thursday, October 4

The Realm of Extreme-Pressure Lubricants—*C. M. Larson, Sinclair Refining Co.*

THE trend toward higher speeds and greater efficiency in the automotive field has created a demand for lubricants of low viscosities at operating temperatures. On the other hand, higher speeds mean higher temperatures. As the rate of heat, generated between two moving surfaces, increases, the viscosity of the lubricant and the thickness of the oil film decreases until seizure occurs.

For a given rubbing speed, the permissible load for mineral oils varies over a narrow limit. So the factors of safety of mineral oils, even though far superior to a few years ago, are low, leaving in several instances little leeway for the future.

Transmission and rear-axle lubricants are discussed in regard to their suitability under extreme pressure.

Extreme-pressure motor-oils have been introduced from time to time, and these are treated with regard to their effect on bearings composed of various metals.

Many types of laboratory testing machines have been proposed for evaluating or classifying extreme-pressure lubricants, and in 1931 the National Bureau of Standards was enlisted to develop a testing machine that would rate the lubricants in the same order as service performance. In January, 1934, the Bureau submitted a finished machine to the Society for consideration, but no final action was taken because a smaller machine was brought out by a group of the Subcommittee.

New England Section Paper

Tuesday, October 9

Fitting the Highway to Traffic—*Clarence P. Taylor, Massachusetts Department of Public Works.*

IN Massachusetts, every opportunity is taken to fit the highway to traffic. Beginning with 1909, the Department of Public Works conducted a State census each three years to ascertain the amount of vehicular traffic on main highways. From 1909 to 1933, vehicular traffic increased 1400 per cent. A chart of the trend of types of accidents shows that rear-end collisions lead the other causes.

The types of new highways that have been built and the improvements made in the older ones are discussed. The author deems it very likely that, if the average speed on highways ever reaches 60 m.p.h., the roadways will have to be designed as channel ways and mechanical control of the vehicles will have to replace human control if any degree of safety is contemplated, pedestrians and crossing traffic being completely eliminated.

According to the author it is more than likely that those developing air transportation will be the first to settle the matter of high-speed highways, because the automobile in its present form and under present conditions is an efficient time-saving mechanism only over a 25-mile radius. Since the airplane has already reached its present stage of development and is making rapid progress toward safety and dependability, it would seem unwise to undertake to build high-speed super-express highways to compete with it over distances where it is so infinitely superior.

Philadelphia Section Paper

Wednesday, October 10

Fuel and Oil Economy for the Operator—*J. C. Geniesse, Atlantic Refining Co.*

INCREASED labor costs, codes and standardization of freight and passenger rates are constantly decreasing margins from which profits must come. Operators must seek new avenues for increasing the economy of operation, and it is natural that they turn to the question of how much can be done with the fuel and oil.

This paper does not attempt to show what savings can be accomplished by the proper choice and use of the fuel and oil, as that is the problem of the individual operator. Instead, it points out the relation between the fuel and oil properties and the performance and life of the engine, so that the operator can attack the problem with some degree of intelligence.

The fuel variables which enter into the picture are given, the portions of the fuel expenditure that represent Federal, State, and city taxes are shown, and the relationship between air-fuel mixture-ratio by weight and the power and efficiency of the engine is indicated. The correct mixture-ratios for different kinds of driving for a given vehicle are given also. These subjects are discussed.

Lubricating-oil economy is treated, the factors affecting and influenced by oil being listed, and the results of tests are stated and commented upon.

In conclusion it is stated that it must be borne in mind that oil and fuel economy includes not only the immediate cost of two materials but their effect on the usefulness and life of the vehicle.

Milwaukee Section Paper

Wednesday, November 7

Some Factors Influencing Gasoline and Oil Consumption—*Henry S. Debbink, Milwaukee Electric Railway and Light Co.*

SOME phases of maintenance of the Milwaukee Electric Railway and Light Co.'s gasoline-vehicle fleet of 213 automobiles and trucks and 184 buses are discussed. The downward trend in its maintenance costs during the last 10 years represents improvements in vehicles and in maintenance methods.

In conclusion, it is stated that gasoline consumption, of vehicles reasonably well maintained, does not depend on the age of the vehicles or the miles from overhaul or piston-ring change; is influenced greatly by carburetion conditions—proper jets, proper float-level, choke operation and freedom from leaks; increases greatly as the number of starts and stops increases; depends on loads carried; is influenced by average daily mileage; is influenced by temperature and weather conditions; is affected adversely by very fast schedules; and is affected adversely if the gasoline is too volatile.

Further, that oil consumption can be controlled by using the minimum practical clearance between pistons and cylinder walls; providing great oil-return capacity in oil-return rings, piston oil-holes and passages; designing pistons so that they are round when hot; replacing rings when they are badly worn or when the oil-return grooves are clogged up; using expanders in back of piston rings in worn cylinders; maintaining correct main-bearing clearance; and preventing excessive crankcase-oil temperatures.

So. California Section Paper

Friday, November 9

History of Racing and Fuel Development—*Frank Elliott, Ethyl Gasoline Corp.*

ABILITY of a car to function continuously has been one of the major goals of the automotive designers, and the developments of design and materials which give our present cars their great dependability are to quite a large extent the by-products of the racing game.

The changing trends in engine design toward smaller cylinders and higher speeds are imposing greater and greater loads on many of the working units of engines and, while the direction of these trends has been rather clearly recognized for some years, development limitations have been imposed by lack of ideally suited materials, cooling limitations and the like. The average car owner never suspects the great amount of research in metallurgy and design necessary to produce relatively inexpensive items such as valve springs to meet today's conditions in average automobiles.

The history of racing on the Indianapolis Speedway is outlined briefly to trace developments which have established the subsequent trends in automotive design. As piston displacement was decreased, the car speed increased, and the contributing factors are stated. Every year has seen developments in horsepower per cubic inch of piston displacement. Other subjects discussed include fuels, fuel consumption, detonation, and compression ratios.

Metropolitan Section Paper

Monday, December 10

A Discussion of Current Problems in Airline Engines—*R. F. Gagg, Wright Aeronautical Corp.*

AN outline of some current problems in aircraft engines with particular reference to the types used for main-line scheduled-transport operations is presented, it being limited as far as possible to a consideration of the conventional four-stroke gasoline engine. Types of airline service are considered and, as regards engine sizes, it is stated that airline service demands engines in a range of sizes from the maximum available to about 250 hp. as a minimum.

Statistics of the present performance of airline engines are given, and it is stated that the horsepower output required to meet the contemplated schedule with the most adverse wind normally expected on the route is a nearly correct measure of the true effective size of the airline engine; further, that its durability and performance should, in general, be judged on that basis.

The importance of fuel consumption is stressed. As to preliminary tests of a new engine, a dynamometer calibration of the sea-level performance-characteristics—which should be extended to cover altitude operation also if the necessary equipment is available—should be made. Data on cylinder cooling are presented, and lubrication problems are treated.

Metropolitan Section Regional Meeting Papers--Nov. 8-10, 1934

Taxation and Regulation as Applied to Highway Transportation—*Maj. Roy F. Britton, director, National Highway Users Conference.*

THE National Highway Users Conference is not an independent or separate association; it is a conference of existing organizations of all classes of highway users. It is a coordinating and information agency and its policies are determined by a governing committee composed of representatives of agriculture and shipping interests, as well as representatives of some of the purveying industries.

For the last few years highway transportation has been on the defensive, largely because an aggressive campaign has been carried on by interests unfriendly to the development of motor transport, and this is having a very prejudicial effect on the public mind as well as on national and state officials and legislators.

The pressing need at the moment, from the standpoint of highway transport, is to lay a solid foundation of facts which must be relied upon to secure a favorable hearing at the bar of public opinion. Highway transportation is not receiving that hearing now. It is being kicked, maligned, burdened, and straitjacketed in a hundred different ways, the paper states. It has been virtually placed on trial by its enemies, frequently without the benefit of counsel or a friend at court.

The paper criticizes the attitude of the railroads toward the users of motor-vehicles, analyzes the present motor-vehicle taxation and motor-vehicle-regulation situations, and makes a plea for justice for the highway users.

The Trend in Taxation and Regulation of Highway Transportation—*Gen. H. V. Markham, director, American Petroleum Industries Committee.*

TAXATION has come to be, in fact, almost a forbidding element in the development of motorized highway transportation. The motor vehicle today is carrying a load of taxation far beyond its just share of Government cost. Motor-vehicle taxes have increased 300 per cent since 1919 and yet the motor-vehicle tax-curve continues to swing upward. On the basis of the total motor-vehicle tax-bill for 1933, the average motor vehicle was taxed $50.47 last year, an increase of $12.75 per vehicle over 1930.

After going into further detail on the trend of taxation, the paper takes up the trend in State legislation, citing 16 subjects on which legislation unfavorable to the motor-vehicle industry is likely during the coming year. The trend in Federal legislation is discussed also.

The author believes that motor-vehicle taxation and regulation should be predicated upon encouragement rather than curtailment in the use of the highways, to the end that the entire public may benefit to the fullest extent from the modern transportation facilities thereby afforded.

High-Speed Compression-Ignition Engines for Motor Vehicles—*N. Mitchell, resident engineer, Asiatic Petroleum Co., Ltd.* (Published in full, page 17, this issue.)

Operation of the Code in the Trucking Industry—*T. V. Rodgers, president, American Trucking Association.*

WHEN the National Industrial Recovery Act was passed in June, 1933, the trucking industry was not organized. The Recovery Program, insofar as codifying industry was concerned, dictated that industry should organize. Here was a mandate from the President of the United States to get together in strong, effective groups to carry out the provisions of the NIRA.

Accordingly, a National organization of truck operators was set up, chiefly for the purpose of developing a Code of Fair Competition for the Trucking Industry. Because of the lack of organization in the industry, it was necessary to develop an organization and, at the same time, to carry out the formulation of a code.

From the divergent opinions of various groups in the motor-transportation fields there emerged one strong National organization representative of all classes of motor-truck operators.

The paper points out some of the important features of the Code for the trucking industry, and their effect on the industry. In conclusion it is stated that the National organization is set up to carry the industry to a solution of its problem, this being dependent in large measure on the strong State organizations which comprise its membership.

Economical Application of Rates for Freight by Motor Trucks—*F. I. Hardy, industrial engineer, Boston.*

THE great problem of the transportation industry as a whole, at this time, is to determine on a sound economical basis what type of vehicle can furnish the cheapest and most rapid transportation to the public. To determine the place of the motor truck, the railroad, water and air transportation, costs for various operations must be found and rates must be based on cost of operation.

While all admit that the cost basis for rates is somewhat complicated, rates will never be equitable and fair to the public and neither will we have the right vehicle performing the right service until these costs are arrived at.

In considering costs, certain fixed and variable fundamentals must be analyzed and many items included in translating costs into rates.

In building rates based on costs for motor trucks and all other forms of transportation, one of the complications has always been the official classification. It is the author's belief that, generally speaking, there are only three items on which classification should be made; namely, pounds per cubic foot, value of the goods, and danger from explosion and liability of injury to other freight.

Basing rates on costs plus a reasonable profit will create an incentive for the operator to give the public the lowest rate that can be had with a reasonable profit to himself.

Propane and Butane as Motor Fuels—***W. Z. Friend, chief technician, and E. Q. Beckwith, industrial engineer, Phillips Petroleum Co.*** **(Published in full, page 36, this issue.)**

Problems of Industry in Using the Highways—***G. E. Clinton, traffic manager, Sheffield Farms.***

THE paper treats factors of motor-vehicle operation that are adverse to business interests, such as restrictions in length, width, height and weight; increased motor-truck fees, which increases must be paid by the public; increased gasoline tax; restriction against the use of highways built for all classes of motor-vehicles; unreasonable regulation of carriers of goods for hire; and unreasonable legislation creating an artificial requirement for the owners of motor trucks.

The author advocates giving to those who pay for the highways—and pay dearly—the right to use them in the peaceful conduct of their businesses.

The International Association of Milk Dealers cannot consistently agree to uniformity of weights and lengths for motor-vehicles, and does not want laws passed restricting weights and lengths because payloads would thereby be reduced and an additional overhead expense would consequently be exacted that would react directly on the consuming public.

Among the conclusions reached are that the roads used by the heavy-duty truck are already in the state systems and no additional sources for taxes for construction of these roads are needed; and that highway stresses are ruled by wheel loads and not gross loads.

Planning and Administering Highway Systems for Greatest Usefulness—***W. J. Sloan, state highway engineer, New Jersey State Highway Commission.***

AFTER reviewing the early history of transportation the author notes the similarity of the problems facing railroad engineers and highway engineers regarding economic operation of vehicles, remarking that:

"If we conceive the highway system as being the property of the citizens of a State, then these citizens are analogous to the stockholders in a railroad company, paying for their interest in taxes rather than by the purchase of a stock certificate, and taking their dividends in the form of highway facilities furnished them and the savings effected in the operation of their motor vehicles rather than in the form of an occasional dividend check when, and if, the railroad is fortunate enough to be able to pay a dividend to its stockholders".

The author analyzes the foregoing conception, discusses the cost of operation of each class of motor vehicle for the conditions imposed by the highway over which the traffic passes, and concludes with the statement that, in the final analysis, the real problem is how to obtain from our highway system the maximum of benefits at a minimum of expense, into which expense the accident toll necessarily figures.

Manufacturers' Part in the Advancement of Motor Transport—***James S. Marvin, assistant general manager, Automobile Manufacturers Association.***

PRIMARILY, the problem of the manufacturer is to attain quality and reliability. He wants his truck to do the job expected of it and he makes himself familiar with those requirements. He must consider safety of operation on the highways and insure adequate servicing. But the truck is not an article that can be sold and then forgotten by the manufacturer. He must interest himself in many questions involving public contact.

The manufacturer has interested himself in regulatory proposals and his right to do so has recently been questioned. But he has also conducted, for example, motor-truck educational campaigns and furthered courtesy on the highways through State Associations and fleet owners. This movement received wide cooperation.

Of outstanding importance, however, are the questions of taxation and regulation. Fortunately, their importance has been growing steadily on commercial interests. Trucking services have attained a definite place in distribution. These users of the highways are now also organized to meet organized punitive proposals. The motoring organizations in the states have grown in number and effectiveness.

The speaker continued by discussing repressive bills promulgated in the various State and Federal legislatures, mentioned that the manufacturers joined with farm and shipping groups in advocating uniform size and weight standards, and took issue against regulation of trucking services. He stated that "regulation" is a word of broad interpretation. It is impossible for those interested in preserving the flexibility of trucking to commit themselves to it unreservedly. Their safe course now is to get experience with the measure of self-regulation provided in the Code.

Air Transport Operations—***E. P. Lott, manager of operations, United Air Lines.***

AFTER citing statistics showing the remarkable development of commercial air-transportation in the United States during the period 1926 to 1933 inclusive, the paper describes present equipment, methods, and general policies of procedure regarding operating factors such as speed with safety, and ability to perform efficiently at wide variations of altitude in weather conditions of practically every type.

The adoption of the Boeing 247 as standard equipment on the United Air Lines paved the way for unification of the company's operations. The system was reorganized into five geographic divisions, as follows: New York-Chicago, Chicago-Cheyenne, Cheyenne-Oakland, San Diego-Portland, and Salt Lake-Portland-Vancouver. The purpose of this plan was to place flight control in the hands of a responsible representative of operations headquarters who would be centrally located in the particular division to permit close contact with all divisional personnel.

This representative is the division superintendent, responsible directly to operations headquarters where operations policies are formulated and administered. The effect of this system has been to increase the margin of safety through the definite control of each scheduled flight by a competent representative of operations headquarters. It is stated that, so far as future development of equipment is concerned, it would appear that for the next few years improvements in aircraft will largely be concerned with powerplants and appointments.

Federal Regulation of Aeronautics by the Bureau of Air Commerce—*F. R. Neely, chief, Information Section, Bureau of Air Commerce.*

THE need for Federal regulation of aeronautics first became apparent to the industry itself and its efforts were largely responsible for the enactment of legislation authorizing the formation of the Bureau of Air Commerce in the Department of Commerce, with powers to regulate and promote aeronautics.

Aircraft manufacturers, operators and others in the industry sought this legislation in order to provide standards of safety, quality and performance to guide the industry and to protect the public. They realized that, if aircraft could be built indiscriminately and flown without restrictions, the public confidence essential to the industry's growth would not be forthcoming.

The Bureau of Air Commerce, under the Air Commerce Act of 1926, which authorized its creation, has set up rules and procedure for practically all major phases of the industry. These regulations are based upon the fundamental purpose of the Bureau of Air Commerce, which is to make certain that civil flying is conducted by competent airmen in airworthy aircraft. The regulations are designed to be of benefit to persons and property in general, as well as those engaged in aeronautics, and particular attention is given to the interests of the air traveler.

The functions and procedure of the Bureau are outlined. All of the regulations are amended from time to time as changing conditions in the aeronautics industry make revisions necessary.

National Tractor and Industrial Power Equipment Meeting Papers

Dec. 5-6, 1934, Chicago

Cylinder Bore and Shape Characteristics—*Kirke W. Connor, Micromatic Hone Corp.*

IN the presence of conflicting authoritative opinions regarding the causes of engine cylinder wear, one point is mutually agreed upon: a smooth cylinder surface greatly increases resistance to wear of all contacting parts. The new Profilograph instrument developed at the University of Michigan has been invaluable in studying and measuring exactly the varying degrees of cylinder finish, in millionths of an inch. It works on the principle of recording deflections of a light beam. The whole industry is going to Mirror Finish; a secondary honing operation. But a high degree of cylinder finish is not enough for the higher operating speeds: Distortion of the bores, due to head strains, must be overcome.

The upward pull of the engine block studs, in drawing down the cylinder head, pulls blow-by pockets in the cylinder walls to an incredible degree. This can be completely overcome in a new patented process.

It is conceivable that the sale of new automotive power units is affected by the practicability of the proper and adequate methods of reconditioning of these engines. In reconditioning engines, an expedient means of securing the above two accomplishments is essentially important and, furthermore, factory limits of tolerance for squareness of the cylinders with the crankshaft must be held. Under hard service, engine blocks become warped so that the cylinders are each out of square with the crankshaft. This new patented process for engine reconditioning is a portable equipment that does four things well within factory limits: Compensates for cylinder distortion, regenerates alignment of the cylinders square with the crankshaft, rids the crankcase of the chips and grit from the reboring and honing operations, and gives the real Mirror Finish to a new base metal surface in one operation.

Piston Rings: Factors Contributing to Their Normal and Abnormal Wear—*J. H. Ballard, S. Nixon and N. A. Moore, Sealed Power Corp.*

WHILE comparatively insignificant in itself, there is probably no part in an internal-combustion engine today that is more vital to successful performance than is a piston ring. It is also true that no other part wears out as quickly, especially when operating under what the authors consider to be abnormal conditions. It may be stated as a corollary proposition that where there is excessive piston-ring wear there is generally cylinder-wall wear. Ring wear which necessitates the early replacement of the piston rings is in itself a factor of importance, but when it is considered that this may be accompanied by the need for cylinder reconditioning and piston replacement, the factors influencing piston-ring wear become tremendously vital to the builders of internal-combustion engines.

This paper discusses some of the factors which the authors' experience indicates have a bearing on abnormal ring wear. They have found that the commercial cast-iron piston-rings of today, when properly designed and manufactured, will function efficiently over a period of many thousand miles, or the equivalent in hours, with very little wear, if operated under what are known as ideal engine conditions. Under actual service-operation, however, these ideal engine-conditions do not usually exist and the following factors—which are discussed in the paper—must be contended with: foreign matter and abrasives, the limitations imposed by engine design and manufacture, lubrication characteristics, abuse of engines, and blow-by.

Air Conditioning as Applied to Internal Combustion Engines—*Fred R. Nohavec, Donaldson Co., Inc.*

IN the early development of the internal combustion engine the wear of moving parts was rapid. The useful operating time of the engine was oftentimes only ten hours. The real cause for this was not understood. But, as the field of operation expanded into agricultural and industrial machines, it was soon discovered that dust was the cause of most of the wear.

The need of air cleaners became apparent, and various types of air-cleaning devices were soon developed. This was the beginning of the great air cleaner industry.

Of the many ideas brought out, the most successful were

(1) the water cleaner, (2) the oily filter, and (3) the oil bath and oil wash cleaners. The latter two are now universally used as standard equipment on modern tractors and to a great extent on industrial engines.

In the oil air-cleaner the air is taken through oil where it is washed. The air then passes through a condenser where the oil is separated from the air and returned to the oil cup for recirculation. These cleaners are highly efficient, ranging as high as 99 per cent. They are easy to service and require comparatively little care.

Before a cleaner is adopted by engine users it must first be proved in the laboratory and field. Many methods of testing the efficiency and capacity of air cleaners are employed. Most of the manufacturers work independently, and as there is no standardized method of testing, each manufacturer has his own method. The result is that almost any kind of results may be obtained, and comparisons can only be made where the same method is followed.

Some standard method of laboratory and field tests for the purpose of comparison, which will give the information desired, should be established.

The final test is, of course, the results obtained in the field under all kinds of service over a period of reasonable length.

The characteristics of a desirable, acceptable cleaner are:

1. Efficiency of 98 and 99 per cent under field conditions.
2. Low restriction of not more than 4 in. to 8 in. of water.
3. Requires minimum attention and is easily serviced.
4. Small and inexpensive.

From the standpoint of engine manufacturers and manufacturers using engines, it is essential that the air cleaner be considered at the time the machine is being designed. At this time the space can be provided for the type of cleaner best suited for the service the machine is designed to do; also, good connections can be made with a saving of installation cost.

Diesel Application to Trucks, Tractors and Buses—*Hans Fischer, Lanova Corp.*

THIS paper points out that with the solid injection Diesel engine, the reliable smooth combustion performance of the old air-injection type has not been duplicated, especially so with the high-speed Diesel engine. To get the specific output as high as possible, and to obtain good fuel economy, it is necessary to have the first part of the combustion approaching the constant-volume cycle, while the rest of the combustion is rather slow. In other words, the rate of burning is a maximum at the beginning and decreases toward the end of the combustion. The rate of burning in a gasoline engine is slow at the beginning and becomes a maximum at the end of the combustion, neglecting the slight after-burning.

Comparison is made with the rate of burning of different types of high-speed Diesel engines, with the one of the gasoline engine.

It is shown that, besides the hydraulic mixing of fuel and air, an increased turbulence is required toward the end of the combustion, to obtain an efficient rate of burning.

A practical, desired indicator-card is shown. The increase of the rate of burning is comparatively small and the rate of pressure-rise is very moderate for the high specific output.

The Lanova engine is explained in which the burning takes place with increasing rate for 80 per cent of the fuel burned compared with the gasoline combustion in which 90 per cent of the fuel burns with increasing rate.

Design and Materials for Valves and Related Parts for Maximum Service—*Robert Jardine and R. S. Jardine, Wilcox-Rich Corp.*

THIS paper calls attention to some of the shortcomings of parts that are and have been in a continual state of change for many years, possibly more so than most other parts in an internal-combustion engine.

Little is said of inlet valves in comparison with exhaust valves because they generally are fairly satisfactory so far as tight seating is concerned, but they are open to the same improvements as to spring-locking devices as exhaust valves are.

The principal essentials for exhaust valves are stated and commented upon, the shape a valve head on the exhaust side should have is discussed, and cylinder and valve-guide design are considered.

The ideal engine, according to the authors, would include the following points, with respect to the valves and their related parts:

(1) Valves of high-strength steel, probably austenitic and sodium cooled if necessary, possibly skirted to keep the gases from projecting oil vapor or particles of carbon onto the stem.

(2) Narrow-faced stellite-seats on these valves.

(3) Stellite-faced or other applied seat rings.

(4) Substantial clamping-type spring-retainer collars.

(5) Spherical rocking-type washers under one or both ends of the springs, or some equivalent device.

(6) Valve guides of non-growing material, probably Ni-resist, preferably not extending into the passage.

(7) No-lash tappets of the hydraulic type.

(8) Cylinders with ports best suited to keeping valves cool, the exhaust manifold being either far removed or cooled so as to avoid feed-back.

Engine Performance at Low Operating Temperatures—*A. J. Blackwood, Standard Oil Development Co.*

AVERAGE present-day gasoline engines and starting equipment limit maximum oil viscosity to 23,000 sec. at 0 deg. fahr. Permissible viscosities at other temperatures are affected by battery output and temperature, and curves are shown relating oil viscosity to starting temperature throughout the temperature range from —15 deg. fahr. to —80 deg. fahr.

Oil pumping may fail when viscosities exceed 35,000 sec. at such temperatures where starting is possible with a viscosity of this magnitude—i. e., about 15 deg. fahr. on the average car. Sludge accumulation is particularly important at low temperatures since water condensation is conducive to emulsion sludge formation, clogging of oil screens with ice crystals and resultant possible engine failure.

The mechanical condition of the engine greatly influences this and the importance of using high viscosity index, non-sludging oil, and maintaining good engine condition are stressed. Wear is accelerated at low operating temperatures and starting at 0 deg. fahr. may give approximately 13 times normal wear during the warm-up period.

Dilution, load, speed, fuels and lubricants are discussed relative to their effect on wear at low temperatures. It is suggested that cold weather operation and maintenance may be materially improved by the use of quality fuels and lubricants; the use of non-corrosive materials in the engine; improvement in design to minimize leakage of combustion products past pistons and exhaust valve guides; and improvement in thermostatic control of engine temperatures.

What Members Are Doing

A. W. Scarratt has just been advanced to the position of chief engineer in charge of all the International Harvester Co.'s automotive engineering activities, "In recognition of his conspicuous achievements as chief engineer in charge of motor truck engineering for the International Harvester Co. since 1927".

Besides supervising engineering developments of motor trucks as heretofore, Mr. Scarratt will have charge of similar work on McCormick-Deering tractors and stationary and portable powerplants.

From 1914 to 1926, Mr. Scarratt was prominently identified with tractor engineering work, holding the position of tractor engineer and later chief mechanical engineer for a well-known manufacturer. Prior to that, he was engaged in railway engineering work and just before joining the Harvester organization in 1927 was chief engineer for the Hyatt Roller Bearing Co.

Mr. Scarratt has long been very active in the Society of Automotive Engineers, being for several years a member of the motor coach and motor truck committee and of the lubricants division committee.

W. D. Reese, who recently joined the International Harvester organization as Mr. Scarratt's assistant, succeeds him as chief engineer of motor truck engineering. Mr. Reese is well known in the motor truck engineering profession and is at present a member of the Society's truck rating committee and the rim committee.

After graduation from Lehigh University in 1916, Mr. Reese became a research engineer for

W. D. Reese

the Remington Union Metallic Cartridge Co. From 1917 to 1919 he was in the research department of the Locomobile Co. In 1919 he joined the engineering staff of the Fifth Avenue Coach Co. and in 1922 became affiliated with the Yellow Truck and Coach Co., being chief engineer of the company's Yellow Sleeve Valve Engine Works. From then on until he joined the Harvester organization, his time was spent on important phases of engineering development work.

E. W. Austin has been appointed general sales manager, automotive division, Timken Roller Bearing Co., Detroit, Mich. He has been connected with the Timken sales organization since 1919, for the past year as sales manager in the Detroit area.

C. H. Cuno, president and treasurer, Cuno Engineering Corp., Meriden, Conn., has been elected a director of the Motor and Equipment Manufacturers Association for a three-year term.

J. F. Winchester has been elected vice-president of the American Trucking Association, and has been elected a member of the board of directors of the National Association of Motor Bus Operators.

A. W. Scarratt

E. S. Cowie is the subject of a recent citation in *Motortrade,* which points out that under his presidency the Automotive Electrical Association has built up its membership to about 700, with 1000 expected to be on the rolls by Jan. 1. Mr. Cowie, by the way, is the first non-manufacturer president of the A.E.A.

Frank G. Born, chairman of the Dayton Section, has resigned to take a three-months vacation. At the expiration of this time he will locate probably in or near Detroit.

Max L. Hillmer is manager of the Heat Transfer Products Corp., Huntington, Ind. Formerly he was general manager of the Saginaw Steering Gear Division, General Motors Corp.

Mark M. Campbell is an instructor at C.C.C. Camp 909, Banning, Calif. He was an instrument checker with the Douglas Co., Santa Monica, Calif.

George C. McMullen has been named vice-president in charge of sales of the Tyson Roller Bearing Co., Massillon, Ohio.

Lt. Col. James R. Hill, chairman of the Baltimore Section, has recently been promoted to his present rank in the Quartermaster Corps, from the rank of major.

Arthur J. Aiers is now costs investigator with the Triumph Motor Co., Ltd., Coventry, England. Mr. Aiers was superintendent for the Sunbeam Motor Co., Ltd., Wolverhampton, England.

Applications Up Again

For the second month, new applications for membership in the Society are hovering around the "50" mark. In the JOURNAL issue for January 1934 the figure was 35. These figures do not include applications for reinstatement, and are regarded by E. F. Lowe, assistant general manager, as an excellent stimulus for the membership activity of our 30th Anniversary Year—1935.

Col. William G. Wall left Indianapolis during the week of Dec. 2 for a combined business and pleasure trip to the Orient.

Fredrick E. Moskovics, representing the Society in the American Standards Association, was reelected vice-president of the A.S.A. at the annual meeting held Dec. 12.

Charles Hugh Chatfield, formerly assistant director of research, United Aircraft & Transport Corp., has been appointed chairman of the technical advisory committee of the United Aircraft Corp.

Fred Glasper, formerly on special inspection at the tractor works of the International Harvester Co., Chicago, is now a foreman at the same plant.

Stanley R. Thomas has joined the Auburn Automobile Co., Auburn, Ind., as development engineer. He was formerly chief engineer, passenger-car division, Continental Motors.

Frank B. Killian, chief automotive engineer, export department, Socony-Vacuum Oil Co., Inc., has returned from a two-months trip to England, France, Germany, Denmark, Norway and Sweden in the interest of his company's engineering work abroad.

Charles I. Preston, formerly designer with the Lawrance Engineering & Research Corp., Linden, N. J., has joined the Ranger Engine Corp., Farmingdale, N. Y., as assistant engineer.

David Gregg, research engineer with the Bendix Research Corp., designed the supercharger used by Wiley Post in his recent flight for the world altitude-record.

Vincent Bendix, past president of the Society, returned to the U. S. Dec. 14 from a European trip which included a visit to Russia. The picture shows him being greeted at the railway station in Moscow by Lev Rubinstein (left) of the Moscow office of the Amtorg Trading Corp.

O. E. Hunt C. E. Wilson vice-presidents of General Motors Corp. whose election to the board of directors of the Corporation was announced in the last issue of the Journal

E. R. Evans, formerly engineer, brake division, Stewart-Warner Corp., Chicago, has joined the brake division of the Eaton Mfg. Co., Cleveland.

J. B. Thorpe, assistant to the president, Climax Molybdenum Co., should now be addressed at 500 Fifth Ave., New York City, consequent to moving of the company's offices.

Harold P. Phillips, former president, Climax Jones-Quinn, St. Louis, Mo., has joined the Hastings Mfg. Co., Hastings, Mich.

Raymond C. Wilson, formerly a designer with the International Motor Co., Allentown, Pa., is now with the engineering department of the A.C.F. Motors Corp., Philadelphia, Pa.

R. F. Lybeck should be addressed c/o Standard Oil Co. of New Jersey, 26 Broadway, New York City.

Fritz Mitschke has joined the Pioneer Engineering & Mfg. Co., Detroit, as checker of tool design.

J. C. Mackie has been appointed chief inspector of mechanical transport, Royal Army Service Corps (Great Britain). The appointment carries with it the rank of lieutenant-colonel. Colonel Mackie is stationed at the Regent's Park Barracks, London.

Wesley B. Pusey, secretary of the Milwaukee Section for a number of years, has joined the staff of the Taylor Mfg. Corp. Mr. Pusey was formerly sales engineer for the Widmeyer Co., Milwaukee.

Walter M. Lipps, field engineer, Russell Mfg. Co., will make his headquarters at the factory in Middletown, Conn., instead of South Bend, Ind., as heretofore.

Pliny Eastman Holt

Pliny E. Holt, former vice-president and director of engineering, Caterpillar Tractor Co., San Leandro, Calif., died Nov. 18 of heart disease. Mr. Holt had been prominent in the development of the army tanks used during the World War, when he was connected with the Army Ordnance Corps. Among the other devices with which his name is connected are a 150-ton tractor-truck, several types of army tractors and a Caterpillar-tractor gun mounting.

Mr. Holt's interest in automotive apparatus began quite early. Shortly after leaving the University of Minnesota he went to California and constructed the first automobile in that State in 1896, building six more in the period to 1900. In 1896 he joined the Holt Manufacturing Co., Stockton, Calif., which had been founded by his uncle, Benjamin Holt. In 1910, he became president of the Holt Co. and continued his connection with it until 1926 when he became vice-president and director of engineering for the Caterpillar Tractor Co. He joined the Society in 1917 and for several years was active in the affairs of the Northern California Section.

In 1923 he was appointed a member of the Agricultural Power Equipment Division of the Standards Committee and the Engine Division of the Standards Committee. Since 1928 he has been a member of the Ordnance Advisory Committee (cooperating with the Ordnance Dept., U. S. Army).

Mr. Holt was born Aug. 27, 1872, at London, New Hampshire, but received most of his schooling in Minnesota.

Henry V. Middleworth

Henry V. Middleworth, superintendent of operations, transportation department, Consolidated Gas Co. of New York, died Dec. 9 of a heart attack. Mr. Middleworth, a graduate of the Cornell University Law School, had been an employe of the Consolidated Gas Co. since 1901, when he began work as an inspector. From 1914 his interests centered on the transportation activities of the company.

He joined the Society in 1926 and in 1927 was appointed a member of the Operation and Maintenance Committee which preceded the formation of the Transportation and Maintenance Activity Committee. In 1929 he became a member of the Transportation and Maintenance Activity Committee and in 1933, a member of the Transportation Division of the Standards Committee. He was active in the work of this Division until the time of his death.

Mr. Middleworth was born July 2, 1871, at Sandy Hill, N. Y.

Albert E. Doman

Albert E. Doman, chief engineer, Owen-Dyneto Co., Syracuse, N. Y., died at his home in Elbridge, N. Y., Nov. 12.

Born in Maiden Bradley, England, Nov. 5, 1870, at an early age he came with his family to this country, settling in Elbridge. In 1890 with his brother, Lewis B. Doman, he organized the Elbridge Electrical Mfg. Co. This company was one of the pioneers in the development of automotive electrical equipment, including spark coils, spark plugs, generators and starters. In 1910 the Elbridge Electrical Mfg. Co. was reorganized as the Dyneto Electric Co. and three years later moved into Syracuse, N. Y. Mr. Doman served as vice-president and chief engineer of this company until 1919, when he resigned to form the Doman Development Co. In 1928 he returned to the Owen-Dyneto Co. as chief engineer and held this position until his death.

Meetings Calendar

S.A.E. 30th Anniversary Dinner

(Annual Dinner) Commodore Hotel, New York, Jan. 7, 1935.

S.A.E. Annual Meeting

Book-Cadillac Hotel, Detroit, Mich., Jan. 14-18, 1935.

S.A.E. Engineering Display

Book-Cadillac Hotel, Detroit, Mich., Jan. 14-18, 1935. (Held in conjunction with S.A.E. Annual Meeting.)

Baltimore—Jan. 3

Engineers' Club of Baltimore; dinner 6:30 P.M. Subject—Traffic and Safety; speakers—Paul L. Holland, chief engineer, Public Service Commission; Preston D. Callum, general chairman, Baltimore Safety Council, chairman Baltimore Traffic Committee; Holger Jensen, manager Engineering and Service Bureau, Maryland Casualty Co.

Canadian—No Meeting in Toronto

Meeting in Montreal during Motor Show week January 26 to February 2.

Chicago—Jan. 29

Hamilton Club; dinner 6:30 P.M.

Experiences with the Code—Barney Majewski, vice-president, Deep Rock Oil Corp., member of Planning and Coordinating Committee of Petroleum Industry.

Lubrication, Particularly with Respect to New Car Developments for 1935, and Its Influence on Safety—William J. Gerwe, manager Automotive division, Socony Vacuum Oil Co., Inc.

Impressions of New 1935 Developments—J. Howard Pile, editor, Chek-Chart Corp.

Dayton—Jan. 17

Engineers' Club; dinner 6:30 P.M. High-Speed Streamlined Trains—J. C. Fetters, Diesel Section General Motors Research Laboratories, and A. H. Fetters, Union Pacific System.

Detroit—January 14-18

Book-Cadillac Hotel; participation in Annual Meeting of the Society.

Metropolitan—Jan. 22

Hotel Lexington; dinner dance 6:30 P.M. Motorboat Meeting. Speakers: William B. Stout, Stout Engineering Laboratories, Inc., and George W. Sutton, American Power Boat Association.

New England—Jan. 15

Walker Memorial, Massachusetts Institute of Technology, Cambridge; dinner 6:30 P.M.

New Car Developments—Dean A. Fales, associate professor, automotive engineering, Massachusetts Institute of Technology.

Northern California—Jan. 22

Engineers' Club, San Francisco; dinner 6:30 P.M. Auto Show Meeting.

Northwest—Jan. 11

New Washington Hotel, Seattle; dinner 6:30 P.M. Lubricating Oil—Sherman W. Bushnell.

Oregon—Jan. 11

Lloyds Golf Club; dinner 6:30 P.M. Brakes—Dr. F. C. Stanley, chief engineer, Raybestos-Manhattan, Inc.

Pittsburgh—Jan. 8

Pittsburgh Athletic Association; dinner 6:30 P. M. Front-end Problems and Service—A. E. Farrigan, Bendix Products Corp.

St. Louis—Jan.

Address by William Littlewood, chief engineer, American Airlines.

Southern California—Jan. 11-12

Richfield Building Cafeteria, Los Angeles; dinner 6:30 P.M. The Automobile Today—G. V. Orr, regional manager, Chrysler Sales Corp. Inspection trip through Chrysler plant 10:00 A.M., Jan. 12.

Washington—Jan. 7

The University Club, Washington, D. C.

New Members Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between Nov. 10, 1934, and Dec. 10, 1934.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Askren, Richard W. (J) supervisor, U. S. Tire Co., Inc., 549 East Georgia Street, Indianapolis; (mail) R. R. 11, Box 28.

Currin, Sydney A. (FM) technical representative, Clayton Dewandre Co., Ltd., Titanic Works, Lincoln, England.

Gray, Alexander (M) president and treasurer, Gray Forgings & Stampings, Ltd., 686 St. Clarens Avenue, Toronto, Ontario, Canada.

Hayward, Henry Francis (FM) works manager, York Motors, William Street, Sydney, N.S.W., Australia; (mail) 18 Hedger Avenue, Ashfield, N.S.W., Australia.

Ruth, Joseph P. (M) president and general manager, Ruth Company, 423 Continental Oil Bldg., Denver, Colo.

Rybkin, Ivan Z. (FM) engineer, designer, Stalin Automobile Plant, Moscow, U.S.S.R.; (mail) 3 Machinstroenia Str., App. 21, Moscow 88, U.S.S.R.

Applications Received

The applications for membership received between Nov. 15, 1934, and Dec. 15, 1934, are listed herewith. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Belinn, Clarence M., superintendent of maintenance, National Airways Inc., Boston, Mass.

Bittner, Raymond, engineer, Smith Aircraft, Chicago.

Boyle, Clete L., president, Industrial Chemical Products Co., Detroit.

Brownson, Harold N., experimental department, Olds Motor Works, Lansing, Mich.

Burlew, Fred Northrop, draftsman, The Glenn L. Martin Co., Baltimore, Md.

Chetwynd-Chatwin, H. H. H., transport assistant, c/o Irq. Petroleum Co. Ltd., Haifa, Palestine.

Clower, James Ira, assistant professor, Virginia Polytechnic Institute, Blacksburg, Va.

Cole, Robert Alexander, test engineer, Wright Aeronautical Corp., Paterson, N. J.

Crawford, Harvey D., district manager, Shand and Jurs Co., New York City.

Doerr, Maxwell H., service department, Reo Motor Car Co., Lansing, Mich.

Dziewonski, Joseph John, engineer in charge of aeronautical engineering department, National Engineering Works, Warsaw, Poland.

Egbert, W. E., district manager, Jadson Motor Products, Seattle, Wash.

Faulkner, George, president, George Faulkner Co., Portland, Oregon.

Fleming, Harvey Carruthers, manager coach division, The White Motor Co., Chicago.

Frolich, Per K., director of research, Standard Oil Development Co., Linden, N. J.

Gibbs, E. R., assistant manager, Socony-Vacuum Oil Co., Chicago.

Gruber, Foster M., test engineer, Wright Aeronautical Corp., Paterson, N. J.

Haines, John F., experimental engineer, Steel Products Eng. Co., Springfield, Ohio.

Hayes, Cecil, development engineer, Automotive Products Co. Ltd., Leamington, England.

Haymore, Baxter A., mechanic, U. S. Army, Fort Bragg, North Carolina.

Kilbey, Alfred John, Liaison engineer, Messrs. Oldham & Sons Ltd., Denton, Manchester, England.

Kirkwood, George M., Pennsylvania Refining Co., Karns City, Pa.

Kunze, Alfred Martin, New York Telephone Co., New Rochelle, N. Y.

LeVan, E. E., general sales manager, Haynes Stellite Co., Kokomo, Ind.

Lindstrom, Herman van Tyle, service manager, Lytle Motor Co., Davenport, Iowa.

Merrill, Marcellus, owner, Merrill Axle Wheel Service, Denver, Colo.

Meunier, Frank C., automotive engineer, General Petroleum Corp., Los Angeles, Cal.

Myers, Carlton M., automotive engineer, Socony-Vacuum Oil Corp., Inc., Albany, N. Y.

Nelson, Charles Phillip, 1918-19th St., Santa Monica, Cal.

Oberreutter, Paul H., electric and hydraulic dynamometer engineer, Mid-West Engineering Works, Chicago.

Phillips, C. S., automotive engineer, John Bean Mfg. Co., Lansing, Mich.

Proceller, William A., salesman, Standard Oil Co. of New York Inc., Brooklyn, N. Y.

Railton, Reid Anthony, chief engineer and director, Thomson & Taylor Ltd., Surrey, England.

Reed, Herbert B., assistant manager, National Reemployment Service, Littleton, N. H.

Ryder, Kenneth F., engineer, Transportation Division, The Panama Canal, Canal Zone.

Sayre, John S., vice president, Highway Trailer Co., Edgerton, Wis.

Sokoloff, Nicholas, vice president, Amtorg Trading Corp., New York City.

Thomas, Alden Peach, diesel engineer, Timken Roller Bearing Co., Canton, Ohio.

Toomey, Humphrey Wallace, division engineer, Pan American Airways Inc., Miami, Fla.

Vesper, Howard G., assistant to Eastern mgr., Standard Oil Co. of Cal., New York City.

Wagner, Claude M., service superintendent, Kings Co. Buick Inc., Brooklyn, N. Y.

Way, E. G. Owen, chemist, Shell Oil Co., Montreal, Que., Canada.

Wiman, Charles Deere, president, Deere & Co., Moline, Ill.

Wolf, Henry J., automotive engineer, General Petroleum Co., Los Angeles, Cal.

Papers Available in Mimeographed Form

UNTIL current supplies are exhausted, copies of the papers listed are available in mimeographed form at a cost of 25 cents per copy to members; and at 50 cents per copy to non-members. Orders should specify the name of the author as well as the title of the paper desired.

Orders must be accompanied by remittance and should be addressed to Sessions Secretary, Society of Automotive Engineers, 29 West 39th St., New York, N. Y.

Ballard, J. H., Nixon, S., and Moore, N. A.
Piston Rings: Factors Contributing to Their Normal and Abnormal Wear

Barish, Thomas
Bearings for Controllable Propellers

Blackwood, A. J.
Engine Performance at Low Operating Temperatures

Bleicher, C. E.
Relative Merits of Precision Manufacturing and Correct Plant Layout to Accomplish Cost, Quality and Uniformity of Parts Production

Bretell, Clinton
How Economies in Motor Vehicle Operation Can Be Effected from an Operator's Standpoint

Briggs, Commander W., and Fox, M. L.
Body Noise

Britton, Roy F.
Taxation and Regulation as Applied to Highway Transportation

Brown, Lowell H., and Herbert Chase
Streamlining—Up-to-date Facts and Developments

Brown, W. C., and Roper, V. J.
The Well-Lighted Car

Bull, A. W.
Tire Noise

Chandler, F. F.
Notes on Steering

Clinton, G. E.
Problems of Industry in Using the Highways

Connor, K. W.
Cylinder Bore Surface and Shape Characteristics

Debbink, H. S.
Some Factors Influencing Gasoline and Oil Consumption

DeSmet, E. C.
Planography—The New Science of Surface Design

Drake, H. W.
Problems of the Fleet Operator

Elliott, Frank
History of Racing and Fuel Development

Foley, Hamilton
The Manufacture and Magnetic Testing of Hollow Steel Propellers

Foster, A. L.
Prospects for Future Diesel Fuels, and Their Available Supply

Froesch, Charles
Some Aspects of Commercial Aviation

Frye, Jack
New Airline Advancements: Maintenance and Operations

Geniesse, J. C.
Fuel and Oil Economy for the Operator

Haarz, W. G., Jr.
Beauty Sells Cars in 1934

Hardy, F. I.
Economic Application of Rates for Movement of Freight by Motor Trucks

Havill, C. H.
Theory and Characteristics of Eclipse Automatic Variable Pitch Propeller

Hazard, S., Jr.
Sound Absorption and Deadening

Jacoby, E. R.
Spark Ignition Engines for Agricultural and Industrial Use

Johnson, W. M.
A Résumé—and Some Conclusions about Automotive Electrical Equipment

Lansing, R. P.
Starters for Diesel Engines

Larson, C. M.
The Realm of Extreme Pressure Lubricants

Lott, E. P.
Air Transport Operations

McCormick, Fowler
The Relation of Engineering to Manufacturing and Distribution in the Farm Implement Industry

McCrory, S. H.
Research in Agricultural Engineering

Markham, H. B.
Trend in Taxation and Regulation of Highway Transportation

Nohavec, F. R.
Air Conditioning as Applied to Internal Combustion Engines

Norris, R. F.
The Automobile Motor Considered as a Sound Source

Padgett, J. E.
Machinery and Equipment Policies in View of the Present Business Situation

Peterson, C. D.
Multi-Range Transmissions

Probst, K. K.
Development of a Transverse Leaf-Spring Independent Wheel Suspension System

Shepard, E. H.
The Economy Fallacy

Sloan, W. J.
Planning and Administering Highway Systems for Greatest Usefulness

Smith, C. W.
Comparative Tests of Pneumatic Tires and Steel Wheels on Farm Tractors in Agricultural Operations

Smith, G. W., Jr.
A Technical Education

Sparrow, S. W.
Problems in the Development of a High Speed Engine

Staley, A. C.
Requirements of Tractor and Diesel Engines

Taylor, C. P.
Fitting the Highway to Traffic

Taylor, E. S.
Design Limitations of Aircraft Engines

Thee, W. C.
Standardization of Military Motor Equipment

Tinkham, G. L.
Truck Refrigeration with Propane

Tirrell, E. L.
Weight Distribution on Front and Rear Axles of Motor Truck

Treiber, O. D.
Factors in Automotive Diesel Development

Veal, C. B.
Mind or Micrometer

Wheeler, P. R.
Human Engineering

Winkler, A. H.
Service Problems and Trends in Motor Vehicle Maintenance

Wolf, A. M.
Lightness in Truck Design

Wright, T. P.
Controllable Pitch Propellers—Design Considerations

Zucrow, M. J.
Some Experiences with Heavy Fuel Equipment for Spark Ignition Engines

Notes and Reviews

THESE items, which are prepared by the Research Department, give brief descriptions of technical books and articles on automotive subjects. As a rule no attempt is made to give an exhaustive review, the purpose being to indicate what of special interest to the automotive industry has been published.

The letters and numbers in brackets following the titles classify the articles into the following divisions and subdivisions: *Divisions*—A, Aircraft; B, Body; C, Chassis Parts; D, Education; E, Engines; F, Highways; G, Material; H, Miscellaneous; I, Motorboat; J, Motorcoach; K, Motor-Truck; L, Passenger Car; M, Tractor. *Subdivisions*— 1, Design and Research; 2, Maintenance and Service; 3, Miscellaneous; 4, Operation; 5, Production; 6, Sales.

AIRCRAFT

The Drag of Airplane Wheels, Wheel Fairings and Land Gears—I

By William H. Herrnstein, Jr., and David Biermann. N.A.C.A. Report No. 485, 1934; 32 pp., illustrated. Price, 10 cents. [A-1]

Vibration Response of Airplane Structures

By T. Theodorsen and A. G. Gelalles. N.A.C.A. Report No. 491, 1934; 22 pp., illustrated. Price, 10 cents. [A-1]

Tests of 16 Related Airfoils at High Speeds

By John Stack and Albert E. von Doenhoff. N.A.C.A. Report No. 492, 1934; 23 pp., with tables and charts. Price, 10 cents. [A-1]

Landing Characteristics of an Autogiro

By William C. Peck. N.A.C.A. Technical Note No. 508, November, 1934; 9 pp., 3 figs. [A-1]

Tank Tests of Flat and V-Bottom Planing Surfaces

By James M. Shoemaker. N.A.C.A. Technical Note No. 509, November, 1934; 25 pp., 34 figs. [A-1]

The Calculated Effect of Trailing-Edge Flaps on the Take-Off of Flying Boats

By J. B. Parkinson and J. W. Bell. N.A.C.A. Technical Note No. 510, November, 1934; 15 pp., 6 figs. [A-1]

A Study of the Pitching Moments and the Stability Characteristics of Monoplanes

By George J. Higgins. N.A.C.A. Technical Note No. 511, November, 1934; 16 pp., 18 figs. [A-1]

The Aachen Wind-Tunnel Balance

By C. Wieselsberger. Translated from *Abhandlungen aus dem Aerodynamischen Institut an der Technischen Hochschule Aachen*, No. 14, 1934. N.A.C.A. Technical Memorandum No. 757, November, 1934; 4 pp., 2 figs. [A-1]

An Investigation of Available Information on the Strength Properties of Reinforced Skin Construction

Prepared by C. G. Brown. Air Corps Technical Report No. 3739. Published by the Chief of the Air Corps, City of Washington; July 10, 1934; 33 pp., with tables and charts. [A-1]

Tests of N.A.C.A. 2218-09 Tapered Airfoil in the Matériel Division Wind Tunnel as Compared with Tests in the N.A.C.A. Variable Density Wind Tunnel—Five-Foot Wind Tunnel Test No. 108

Prepared by H. H. Jacobs and R. L. Bayless. Air Corps Technical Report No. 3880. Published by the Chief of the Air Corps, City of Washington; July 10, 1934; 6 pp., illustrated. [A-1]

Handbook of Aerodynamic Formulae

Prepared by R. B. Ashley. Air Technical Report No. 3956. Published by the Chief of the Air Corps, City of Washington; July 10, 1934; 14 pp., with tables. [A-1]

(Continued on page 32)


For 18 Years-Pioneers in the Lubrication that made this Amazing Progress Possible
INES
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In the future, as for 18 past years, automotive engineers may depend on Alemite to discover, develop, and deliver the new kinds of lubricants and lubricating methods that will smooth the way for continued automotive progress. The Alemite Corporation is proud of its association with S. A. E. and of its part in this progress.
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NOTES AND REVIEWS

Continued

Airworthiness Requirements for Aircraft

Aeronautics Bulletin No. 7-A of the Bureau of Air Commerce, U. S. Department of Commerce, City of Washington; 1934; 58 pp., with charts. [A-1]

Air Commerce Regulations Governing Scheduled Operation of Interstate Air Line Services

Aeronautics Bulletin No. 7-E of the Bureau of Air Commerce, U. S. Department of Commerce, City of Washington; October, 1934; 21 pp. [A-1]

Design Information for Aircraft

Aeronautics Bulletin No. 26 of the Bureau of Air Commerce, U. S. Department of Commerce, City of Washington; October, 1934; 59 pp., 6 tables, 28 figs. [A-1]

Servo Control Flaps

By Elliott G. Reid. Published in the *Journal of the Aeronautical Sciences*, October, 1934, p. 155. [A-1]

Although the direct manual operation of the controls of any existing airplane may be rendered satisfactorily light by known methods of balancing, the servo control flap, according to the author, is of great potential value as a control operating or balancing device and as a means of maintaining trim without effort on the part of a pilot.

Le Challenge International d'Aviation de Tourisme

By Louis Hirschauer. Published in *L'Aéronautique*, November, 1934, p. 254. [A-4]

In a critical review of the 1934 international aircraft competition held in Poland, the author reviews the factors governing the judging of the merits of the various aircraft, points out certain lessons learned from the results of the tests and recommends changes to be made in the rulings for the next similar event.

Shop Practice—Working and Welding Stainless Steel—Tube Bending—Building Radiator Cores Using High Melting Point Solder (A. C. Specification 11064)

Prepared by Lieut. D. G. Lingle. Air Corps Technical Report No. 3820. Published by the Chief of the Air Corps, City of Washington; Sept. 8, 1934; 6 pp., illustrated. [A-5]

CHASSIS PARTS

Die Schmierung von Kraftfahrzeuggetrieben

By Ekart Graf Soden Fraunhofen. Published in *Automobiltechnische Zeitschrift*, Oct. 10, 1934, p. 503. [C-1]

To provide a low-viscosity oil as lubricant for present-day highly stressed transmission gears is not sufficient; the constant-level system of lubrication must be replaced by a system in which the lubricant is actually sprayed on the gears. This is the conclusion drawn at the close of this report of the research carried out by a German gear manufacturer to find a suitable lubricant for automotive transmission gears.

ENGINES

The Cooling of Finned Cylinders

By Arnold E. Biermann and Benjamin Pinkel. Published in the *Journal of the Aeronautical Sciences*, October, 1934, p. 178. [E-1]

The authors give an analysis of heat flow in finned cylinders in an attempt to derive a method for determining the lightest fin construction for a required heat transfer consistent with manufacturing practice.

New 50 Hp. McCormick-Deering Diesel Starts on Spark Ignition

Published in *Automotive Industries*, Nov. 24, 1934, p. 648. [E-1]

The new engine can be hand-started with magneto-spark ignition. An auxiliary combustion chamber is provided which reduces the compression ratio to Otto cycle requirements for gasoline operation. As the engine comes up to speed, the governor closes a valve to the auxiliary chamber which raises the compression ratio; at the same time the magneto is disengaged, and a butterfly valve closed in the carburetor riser. The fuel injection system is likewise governor controlled.

The Processes in Spring-Loaded Injection Valves of Solid Injection Oil Engines

By O. Lutz. Translated from *Ingenieur-Archiv*, Vol. IV, No. 2, 1933. N.A.C.A. Technical Memorandum No. 758, November, 1934; 24 pp., 11 figs. [E-1]

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NOTES AND REVIEWS

Continued

Note Sur Les Conséquences Possibles De L'Emploi Dans Les Moteurs Des Carburants À Haute Valeur Antidétonante

By C. Bonnier and M. Moynot. Extrait des *Annales de l'Office National des Combustibles Liquides*, 1934, No. 3, pp. 481-488. [E-1]

Fuels of high antiknock value tend to increase the temperature of exhaust gas and hence of valves, causing overheating of valves and the necessity for valve cooling. To investigate this problem, a series of tests was run at the national station at Belleville on the C.F.R. engine using various mixtures of lead tetraethyl, gasoline-benzol and gasoline-alcohol, and noting exhaust gas temperature. The conclusions drawn are that for engines functioning normally in the detonating range, such as aircraft engines, increase in exhaust-gas temperature is quite marked, but is less for automobile engines which are not taxed to the point of maximum performance, and that the subject of fuels should be studied in conjunction with all phases of engine operation.

Zylinderzahl, Schwungradgrösse und Beschleunigungsvermögen von Viertaktmotoren für Personenwagen

By E. Marquard. Published in *Automobiltechnische Zeitschrift*, Oct. 10, 1934, p. 491. [E-1]

The quest for smooth idling operation leads to a large flywheel; however, such size increase reacts unfavorably on accelerating ability. In the effort to point the way to a proper compromise, the author analyzes mathematically the relationships between the number of cylinders, flywheel size and accelerative ability of an engine.

Planung und Aufbau Schnellaufender Zweitaktmotoren

By Herbert J. Venediger. Published in *Automobiltechnische Zeitschrift*, Oct. 10, p. 495 and Oct. 25, 1934, p. 529. [E-1]

Because it is under consideration in connection with the development of a low-priced passenger-car for popular use, the two-stroke cycle engine is said to have assumed a position of importance. The conclusion reached as a result of this analysis of the present state of the art and possible future design developments, is that the two-stroke cycle is eminently adapted for small and large-sized powerplants, with the four-stroke cycle filling in the intermediate range.

Ein Neuer Elektrischer Indikator für Schnellaufende Verbrennungskraftmaschinen

By C. W. Fieber. Published in *Automobiltechnische Zeitschrift*, Oct. 25, 1934, p. 523. [E-1]

A new electrical indicator said to have been tested and approved by engineering college at Wien is here described and examples of its use given.

Zundung und Verbrennung im Dieselmotor

By G. D. Boerlage and J. J. Broeze. Reprint from *Forschungsheft 366*, supplement to *Forschung auf dem Gebiete des Ingenieurwesens*, May-June, 1934; 8 pp., 12 ill. [E-1]

Responsibility for further improvement in Diesel engine performance is placed squarely with Diesel engine designers, in this article dealing with mixture, ignition and combustion processes in such engines. According to the authors, progress should lie in designing engines to use available fuels, instead of seeking to change fuel characteristics.

HIGHWAYS

Merchandise Traffic Report

Prepared by Section of Transportation Service, Federal Coordinator of Transportation, City of Washington, 1934; 422 pp. For sale by the Superintendent of Documents, City of Washington; price, $1.25. [F-1]

The report concludes that the railroads have lost the bulk of the available merchandise traffic which they formerly handled. As now conducted, highway transportation of merchandise is relatively more economical than rail transportation for all distances. Adoption of potential improvements would make rail transportation generally more economical for distances over 150 miles. For hauls of 75 miles or less, highway transportation would continue to be the more economical.

Suggestions are made in the direction of pooling all rail merchandise services into two competing merchandise agencies, each nation-wide, operated under independent management and encouraging L.C.L. consolidation, direct routing, store-door collection and delivery service, improvements in shock-proof equipment, higher average speeds than now prevail, and simplification of classification and packing requirements. It is further recommended that rail and highway transportation be coordinated so that merchandise will be concentrated at and delivered from a few stations by highway, and moved between stations by rail in car lots.

(Continued on page 36)

"Barney" Roos,
Chief Engineer
Studebaker Corp.

"The modern phenol-compound and fabric base type of gear is one of the most satisfactory means for camshaft drive yet provided for high speed engines."

D. G. Roos

THE 1935 STUDEBAKER CHAMPION WITH INDEPENDENT PLANAR WHEEL SUSPENSION—COMPOUND HYDRAULIC BRAKES —BRILLIANT NEW BODY DESIGN—AND A SMOOTH EFFICIENT MOTOR THAT IS SPOKE CELORON GEAR TIMED.

that's why ALL 1935 STUDEBAKERS are CELORON SPOKE GEAR TIMED!

Critical vibrations do not affect the "Spoke" Celoron Silent Timing Gear. The added resilience of this type of silent timing gear enables it to absorb vibrations, preventing tooth wear and the consequent development of excessive backlash. Another unusual feature about the "Spoke" Celoron Silent Timing Gear is that even when excessive backlash does exist it does not result in the timing gears becoming noisy. The explanation for this seeming phenomenon is that the "Spoke" Celoron Silent Timing Gear effectively resists any tendency to synchronize with vibrations set up in the timing mechanism.

An up-to-date data book on timing gear installations has just been prepared by our Engineering Department which contains many drawings of designed "Spoke" Celoron Silent Timing Gears. We shall be glad to send you a copy if you will write for it.

CONTINENTAL-DIAMOND FIBRE COMPANY

NEWARK DELAWARE

NOTES AND REVIEWS

Continued

Proceedings of The Thirteenth Annual Meeting of the Highway Research Board

Edited by Roy W. Crum. Part I, Reports of Research Committees and Papers. Published by the Division of Engineering and Industrial Research, National Research Council, City of Washington, 1934; 412 pp., illustrated. [F-1]

Papers of special interest to the automotive engineer include the following:

The Engineering Valuation of Highway Systems, by Anson Marston;
Making and Using the Traffic Census, by E. W. James;
The Economy of Highway Improvements, by Howard Burton Shaw;
Further Tractive Resistance Tests with a Gas Electric Drive Automobile, by Raymond G. Paustian;
Skidding Characteristics of Road Surfaces, by R. A. Moyer;
Coefficient of Friction Between Tires and Road Surfaces, by Karl W. Stinson and Charles P. Roberts;
Intangible Economics of Highway Transportation, by C. A. Hogentogler, E. A. Willis and J. A. Kelley;
Highway Lighting Research, by Arthur F. Loewe;
Motor Vehicle Accidents as Reflected by Psychological Tests and Reaction Meter, by W. A. Van Duzer;
Notes on Traffic Speeds, by A. N. Johnson;
Alcohol and Motor Vehicle Drivers, by W. R. Miles;
The Photographic Method of Studying Traffic Behavior, by Bruce D. Greenshields.

Skidding Characteristics of Automobile Tires on Roadway Surfaces and Their Relation to Highway Safety

By R. A. Moyer. Bulletin No. 120, Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa; Aug. 8, 1934; 128 pp., illustrated. [F-1]

All of the important phases of skidding related to highway safety were analyzed in this investigation. The relative importance of skidding as a cause of highway accidents was determined from a study of highway accident statistics for Iowa and Connecticut. Coefficients of friction for new tread and smooth tread tires on wet and dry surfaces were measured for both straight ahead and sideways skidding at speeds of 3 to 40 miles per hour using a two-wheel trailer test unit. A significant development of these tests was the integrating dynamometer designed for measuring the skidding forces.

Tests were run upon a wide range of road surfaces. Many tests are reported showing the effects of tire pressure, wheel loads, types of tire tread, and temperature.

MATERIAL

New Cadmium-Silver-Copper Bearing Alloys Developed by Federal-Mogul

By Athel F. Denham. Published in *Automotive Industries*, Nov. 24, 1934, p. 640. [G-1]

A report on a new bearing metal to be used in 1935 production by motor manufacturers for which the following claims are made:

1. Higher melting point than babbitt
2. Readily bonded to the usual bearing back materials
3. Higher physical properties than for tin-base metals
4. Same clearances as babbitt
5. Does not require hard crankshafts
6. Greater resistance to corrosion than high-lead-bronze.

66 Causes of Defects in Finished Steel Parts

By Werner H. C. Berg and Stanley P. Rockwell. Published in *Product Engineering*, October, 1934, p. 382. [G-1]

A table of defects and suggested means of examination to determine the cause are given.

Strength of Chrome-Molybdenum Tubing Under Bending Due to Transverse Loading

Prepared by C. G. Brown and F. M. Carpenter. Air Corps Technical Report No. 3860. Published by the Chief of the Air Corps, City of Washington; July 10, 1934; 35 pp., illustrated. [G-1]

Tests on Aluminum Alloy Sheet to Determine Allowable Bearing Values

Prepared by C. G. Brown and S. R. Carpenter. Air Corps Technical Report No. 3884. Published by the Chief of the Air Corps, City of Washington; July 10, 1934; 35p p., illustrated. [G-1]

(Continued on page 38)

NOTES AND REVIEWS

Continued

Proceedings—Fourth Mid-Year Meeting—American Petroleum Institute—Section III—Refining [G-1]

Papers of special automotive interest presented at the meeting held at Pittsburgh, Pa., May 22 to 24, 1934, and published in this section of the Proceedings, include the following:

The Problem of Viscosity of Lubricants, by M. R. Fenske and W. B. McCluer, p. 29;

Economic Aspects of Solvent Refining of Lubricating Oils, by Robert E. Wilson and P. C. Keith, Jr., p. 38;

Fuels for Spark-Ignition and Compression-Ignition Solid-Injection Engines, by James B. Fisher, p. 46;

The Relation of Fuel Octane Number to Engine Compression Ratio, by C. D. Hawley and Earl Bartholomew, p. 55;

Conservation of Volatile Gasoline Materials, by W. Mendius and W. G. Ainsley, p. 68;

Butane—A Wasted Asset of the Petroleum Industry, by R. C. Alden, p. 74.

Possible Causes for Bearing Failure

By C. H. Leis. Published in *Product Engineering*, October, 1934, p. 377. [G-1]

The author explains the importance of grooving and discusses various types of bearing failure.

Schmiermittel für Automobil- und Flugmotoren

By Hans Vogel. Published in *Automobiltechnische Zeitschrift*, Sept. 25, 1934, p. 474. [G-1]

In attempting to answer the question, "Are there today any simple laboratory methods by which the suitability of an oil for an internal-combustion engine may be determined easily and quickly?", the author capitulates the laboratory tests which have a practical application and then enumerates the pertinent qualities which can not be determined in the laboratory.

Book of A.S.T.M. Tentative Standards

Published by the American Society for Testing Materials, Philadelphia; 1257 pp. [G-3]

The 1934 edition of this book, which is issued annually, is now available.

MISCELLANEOUS

Kraftfahrtechnische Tagung

Published in *Automobiltechnische Zeitschrift*, Nov. 10, 1934, p. 541. [H-1]

A report is here given of the sessions of the recent meeting of the Association of German Engineers held under the auspices of the automotive and aircraft section of that organization. The papers summarized deal with legislative and administrative assistance to the automotive industry; the relation between the number of axles, axle loads and weight of motor-trucks; domestic fuels; the interaction of vehicles and highways; lubricants; air resistance of motor vehicles; standardization and interchangeability; hydraulic and mechanical transmissions.

Machinery's Handbook

Published by the Industrial Press, New York City, November, 1934; 1592 pp. [H-3]

The Ninth Edition of the Handbook is now available.

MOTOR-TRUCK

Untersuchung der Achsdrücke im Fahrbetrieb in der Ebene, in der Steigung und im Gefälle von Zwei- und Dreiachsigen Lastkraftwagenzügen

By Heinrich Meye. Published in *Automobiltechnische Zeitschrift*, Nov. 10, 1934, p. 558. [K-4]

In view of a recent governmental ruling affecting street and highway usage, axle loads have become of particular significance in Germany. In this article an analysis is made of the road pressures exerted by two and three-axle tractor-trailer combinations on the level, on ascents and on descending grades.

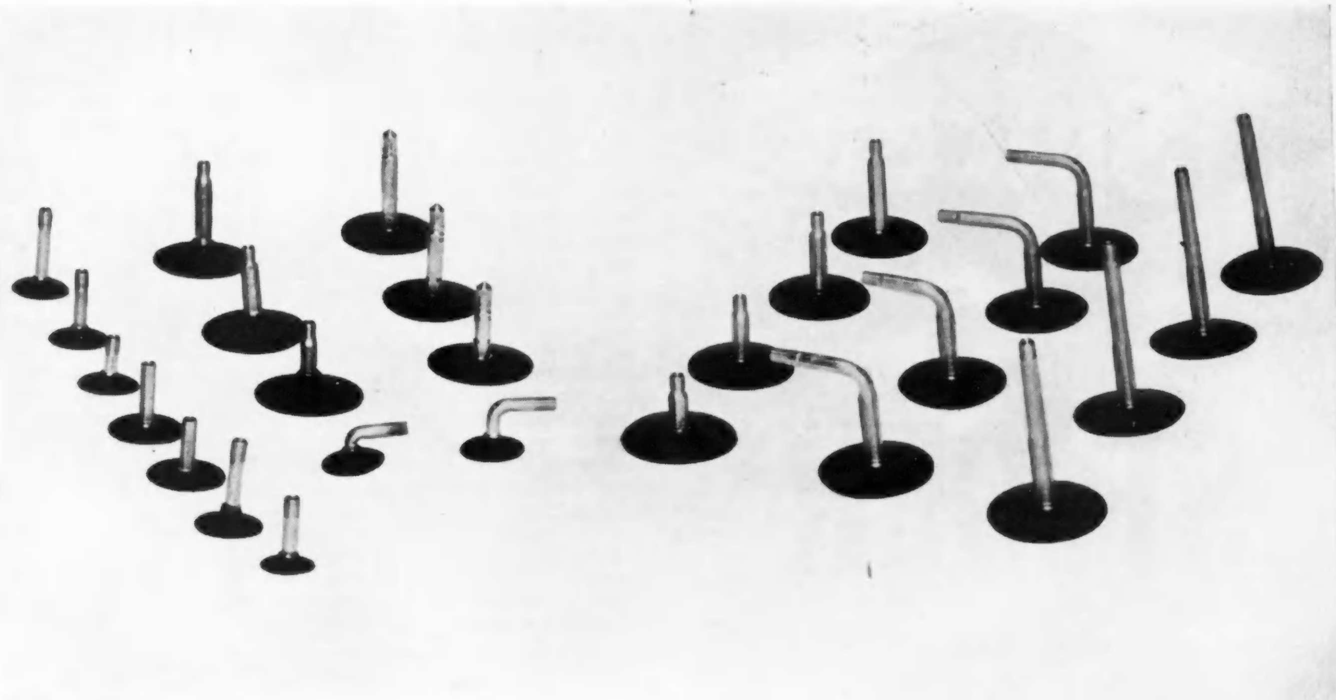
PASSENGER CAR

Dodge Investigations of Riding Fatigue Provide Basis for Quantitative Measurement of Individual Causes

By A. F. Denham. Published in *Automotive Industries*, Oct. 6, 1934, p. 414. [L-1]

Six tests used by A. H. Ryan, M.D., to determine various effects of

(Concluded on page 40)

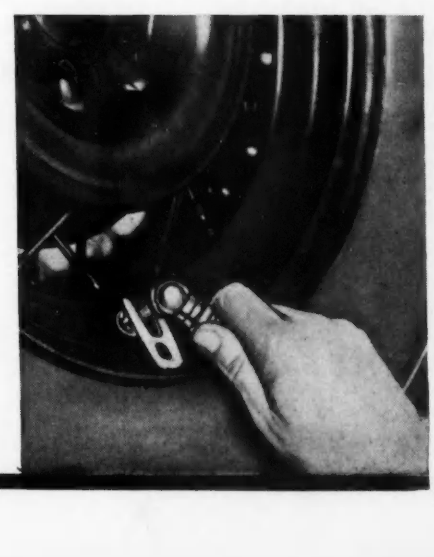


YOU CAN STANDARDIZE WITH DUBLTITE
. . . EASIER MOUNTING AND INFLATING

THE new Schrader DUBLTITE Rigid *All-metal* Rubber-covered-base Valve Stem is not only the most complete answer to the current demand for a "one-piece" tube and valve; but it is also the logical valve to meet the trend toward the varied types of wheel construction of the future . . . it is the *only* built-in valve which can readily be applied or adapted to all types and sizes of rims and wheels.

The Schrader DUBLTITE permits a minimum number of valve-stem sizes, bends and shapes. And the rigid sturdiness of the DUBLTITE's full-length, all-metal barrel assures the firm application of extensions when necessary. It means more! It makes tire mounting and inflating easier. DUBLTITE is rugged . . . resists severe weather conditions, chafing and strain at the rim hole.

Automotive engineers can readily see the many other advantages of the Schrader DUBLTITE—not the least of which is the attractive wheel trim it permits through the chromium "Ezemount" cap that fits snugly to the rim, with or without ferrule. And the trade and public, too, will be quick to appreciate them for their ease of servicing and sturdy performance. Specify Schrader DUBLTITES on the tubes you buy . . . they meet all requirements. Scovill Manufacturing Company, Incorporated, A. Schrader's Son Division, Brooklyn, N. Y.; Toronto, Canada. *Makers of pneumatic valves since 1844.*



NOTES AND REVIEWS

Concluded

fatigue are described. The investigation is said to provide a basis for further work which would establish standards for fatigue measurement.

Tractive Resistance as Related to Roadway Surfaces and Motor Vehicle Operation

By R. G. Paustian. Bulletin No. 119, Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa; Aug. 1, 1934; 64 pp., illustrated. [L-1]

An analysis of motor vehicle tractive resistance and its separation into rolling resistance and air resistance is given. The relative merits of towing, decelerating, coasting, and direct methods of measuring tractive resistance are discussed, followed by a complete description of the gas-electric drive test car used in this investigation, its equipment, and the direct testing procedure employed. The explanations, tables, and figures present results of laboratory calibrations of the test car, of road tests showing the effect of road surfaces on power requirements, gasoline and consumption, and tractive resistance, and of the effect of impact and wind on resistance. The power requirements and gasoline consumption required on grades are also discussed. The effect of speed and air temperature on tire temperature, and the effcet of speed on the rolling radius of the tires are shown. A partial bibliography is appended.

TRACTOR

A Comparative Study of Pneumatic Tires and Steel Wheels on Farm Tractors

By C. W. Smith and Lloyd W. Hurlbut. Bulletin No. 291, The University of Nebraska College of Agriculture Experiment Station, Lincoln; September, 1934; 40 pp., illustrated. [M-1]

The results of the investigation show an improvement in fuel economy with the use of rubber tires, in twenty-two out of twenty-four tests, under varying conditions and with several makes of tractor. Riding comfort is improved, and the speed with rubber tires is a trifle faster.